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Belt Conveyors Build Corewall and Embankment for Wanaque Dam in New Jersey

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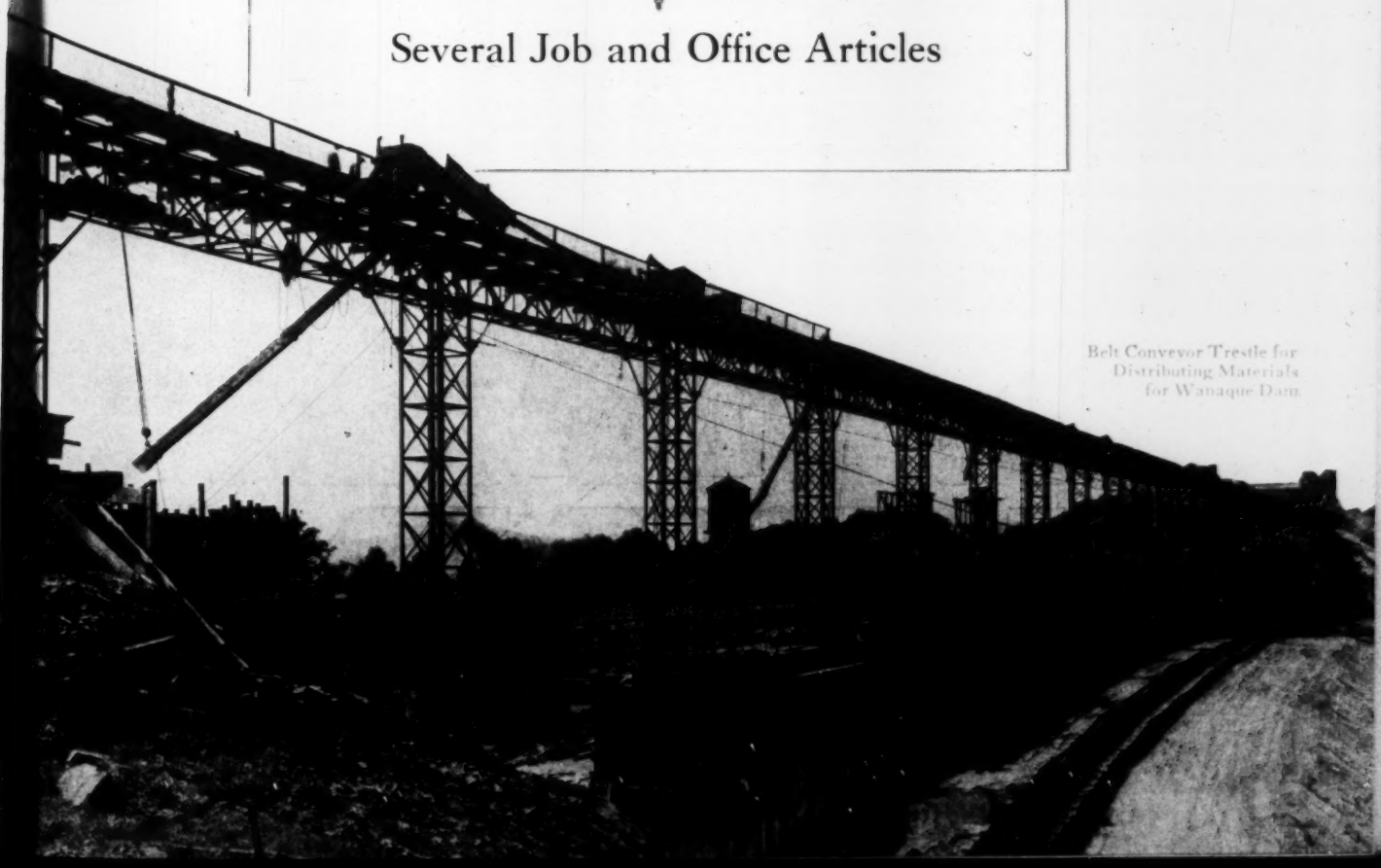

Belt Conveyor Trestle for Distributing Materials for Wanaque Dam

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

FRANK C. WIGHT
Editor

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Job Haulage by Belts

MACHINE operations in dry embankment construction of earth dams have seldom been carried further than on the Wanaque Reservoir dams described in this issue. Virtually no part in excavating, carrying or placing the earth is performed by hand, unless there be considered the preparatory grubbing and the final picking of roots and sticks from the impervious fill. Conveying is the spectacular performance. It is all done by belts of greater width and single lengths than have often been used and of far greater aggregate footage than has ever been recorded on previous construction operations. Crushed stone and gravel and sand production call for some large aggregations of conveyors—one recently mentioned by *Rock Products* has 4,923 ft. of conveyor or very nearly two miles of belt—but none is the equal of that at Wanaque with its five miles of belt and its transmission distances of between three and four thousand feet. A notable detail too of the Wanaque installation is the steepness of some of the belt grades. Gravel is moved successfully up 25 per cent grades, and cement in bags takes nearly a 45 deg. climb. Altogether the continuous conveyor, as a substitute for railway and road haulage, reaches about its extreme application in construction at Wanaque.

County Engineers

MANY careful observers think that the county is now the weakest—and often the rottenest—spot in our government, not having kept pace with either the cities or states in honesty and efficiency. This is shown not merely by deficient county health organizations, as was commented on in our issue of July 23, but it is also evident in highway and bridge administration, where, notwithstanding the large sums being spent by the counties for roads and bridges the engineering organization in county after county and state after state is wofully deficient. Data collected by us indicate that in mere numbers county engineers *and surveyors* outnumber full-time health officers, but the information on which this conclusion is based takes no account of whether these engineers and surveyors are on full-time, nor of their qualifications. As to the latter, it is known that the laws of some states that call for county engineers or surveyors fail to specify qualifications for the office, not even providing that a "county engineer" shall be an engineer in fact. Indeed, there are numerous instances on record where he is anything but an engineer. County administration in the United States needs strengthening and in hundreds of instances cleansing as well. The fact that there are now 267 full-time county health officers and the knowledge that there are altogether a considerable number of able county engineers is encouraging rather by contrast with the past than as measured by the needs and standards of today.

Uniform Road Markings

THE joint board on interstate highways sitting in Washington last week, made up of representatives of the various states, got most of its publicity from the fact that it is laying out through transstate routes which will be marked as such on maps and on the roads themselves and which will, the states themselves willing, be provided with uniform signs and markers. This is useful and desirable work but its major value lies more in the possibility of such uniform marking being extended than in the actual utility of the through routes. After all such routes can be only a small part of all the road system and will be needed by a minority of the motorists, passenger or freight. But if the states can get together and establish some sort of uniformity of traffic guiding principles for their roads, this uniformity may gradually extend to all the road systems and in time rise superior to the intense individualism in this matter that now prevails. Absolute uniformity of signs and guides is, of course, not demanded by any but the most bigoted standardizationist, but some approximation to the same kind of markings is necessary for safe driving and certainly a great convenience to the road user.

Hazards of Remodeling

FEW structures fail when once erected. In other words, the strains and trials of erection are in themselves a test of ability to resist the greater but generally less concentrated loads of use. This is particularly true of the ordinary house or small building which so often defies the engineer's analysis of stress but which built in accordance with the craftsman's inherited knowledge manages to stand and serve despite apparent violation of the laws of stress and the ordinary application thereto of the factor of safety. The continued service of such structures, however, is apt to prove a danger, when once the craftsman takes it into his head to remodel one of them. Because the house has been standing for years subjected to loads and winds, it takes on a fictitious stability, which leads to the most outrageous liberties with its frame and footing in the demand for change of form or style. Here is a hazard that engineers can hardly guard against, for rarely have they anything to do with such alterations. But it is distinctly a field for the building department, or even for the law. For it is a fair statement that there is more hazard in the remodeling of the ordinary structure than there is in its construction and the requirements for the former could reasonably be made more severe than for the latter. Hardly a week passes that there is not recorded the failure, with fatal consequences, of some supposedly insignificant building under repair. All such repair work, from the smallest dwelling up to the major structure, needs watching and the city authorities should remember it.

One Mountain Comes to Mahomet

CANADIANS who have been maintaining that industry must come in to the Dominion for cheap hydro-electric power if that power is prohibited by law from crossing the boundary will rejoice at the announcement that the Aluminum Company of America plans to build a huge plant for the manufacture of aluminum on the Saguenay River in Quebec at a point close to the head of navigation where bauxite for the manufacture of aluminum can be brought from South America by water without trans-shipment, and where a neighboring power site has an estimated capacity of several hundred thousand horsepower. It must be admitted that this announcement is a strong argument against the export of power, but the fact should not be overlooked that such industrial developments as this of the Aluminum Company of America are very unusual and the peculiar situation on the Saguenay is well suited to that company's needs because much of its raw material is imported. Few such developments can be expected to occur in a long period of years and the fact remains that a good deal of power will go undeveloped for a long time unless Canada makes more favorable provisions for the export of power. As a result many small Canadian industries that need cheap power in order to expand will have to struggle along without it simply because the local demand is not sufficient to warrant power investment.

What Chance Cheaper Electricity

THOUGH it is common knowledge among engineers that the cost of the initial production of electricity is only a fraction of the cost to the consumer the popular mind is still obsessed with the idea that the under-development of our water powers is a high crime which is annually piling up an enormous charge against the public. It would be well therefore for every engineer at every opportunity to get across to the layman the real facts. Such facts were well digested in a paper last winter by P. T. Davies, commercial manager of the Southern Canada Power Co., and just published in the *Journal* of the Engineering Institute of Canada. Mr. Davies analyzes the costs, original, operating and depreciation, of generation, transmission and distribution of the average electric power project and shows, what every engineer knows, that distribution is the major expense in the cost of power to the consumer. His conclusions are so emphatic, however, that they should be used by the engineer when he has a layman to persuade. "If power were developed by a philanthropic institution and given free of charge to distributing companies at the point of generation, the price could not be decreased to the ultimate consumer by more than half a cent per kilowatt-hour. A good steam plant, situated near the coal fields can produce power just as cheaply in a fair size city as it can be laid down from a water power which is situated any considerable distance away." And he adds, looking into the future, "Power companies will be able to give cheaper rates to the consumers only by passing on the burden of the distribution expense to the consumers themselves. I see in the future all residence consumers served at 2,200 volts with individual transformers. . . . Supplying power in bulk in this way, the price may easily be brought down to between 2 and 3 cents per kilowatt-hour."

Contingent Fees for Engineers

"WHAT," says a correspondent, "is your opinion of the value of services rendered by engineers who are willing to prepare plans and specifications for a municipality with the understanding that they are not to be paid for if the proposition fails to carry at a public elections?" The answer is obvious. Contingent fees in any professional work are regarded as unethical, and those who consent to do professional work on a contingent fee basis are violating the fundamental ethics of their profession. Whether or not the specific performance under a contingent fee will be inadequate is another matter, for ethical principles are general and do not invariably apply. The basis of the code rules against contingent fees is that the service rendered must suffer if the one rendering it is not sure of his compensation therefor. In the case of engineering services noted in the query this is even more apt to be true than in the more common case of the lawyer's contingent fee, for the lawyer has in a way some control over the possibility of the pay being forthcoming whereas the engineer has not. No lawyer will take a contingent case unless he has more than an even chance to win it and the winning may be largely determined by his conduct of the case. The engineer making municipal plans, however, has no control over the electorate nor has he any more than a layman's guess as to how that electorate will vote. His work is, therefore, only a gamble, and must in most instances suffer from that disability. If the assurance of the project's approval is such that he feels he is taking no chance of its being turned down, his professional position would be greatly strengthened if he insisted that the city itself take that small chance.

Getting Winter Construction

WINTER idleness in the building trades is being fought with unusual success in Rochester, N. Y. The campaign has been carried on primarily by the Community Conference Board sponsored by the Chamber of Commerce. This board is made up of men representative of various interests in the construction industry and began work in the fall of 1921. Its effectiveness was shown almost immediately. During the first winter of 1921-22, as a result of publicity urging winter remodeling and redecorative work, over 17,000 days of work were provided. An increasing amount of this work has been done every succeeding winter. In 1921 the December-March permits for building were 20 per cent of the year's total. In 1924 they were 27 per cent of this total. Thus the work is going on, filling up the valley of winter idleness. And, it is important to note, no unusual methods have been employed. Through the newspapers, by circulars and pamphlets, by talks to the public, building owners have been instructed that much work commonly done in summer may be done in winter as cheaply and commonly better done because there can be a choice of workmen and the work need not be rushed. Again it is pointed out that the means of education have all been old and familiar means—they have merely been employed intelligently and persistently. Cities which have a winter unemployment problem, and few cities are without it, will do well to ask the Rochester Community Conference Board for its recent pamphlet, "What One City Has Done to Stabilize the Building Industry."

Water Supply a Government Function?

WATER-WORKS men on municipally-owned systems, from whom federal income taxes back to 1918 are being demanded, are challenged by the recent federal district court decision which holds that salaries earned in the Detroit street municipal railway department are exempt from the federal income tax. The challenge lies in the fact that the reasoning on which the decision is based accepts earlier opinions that "furnishing water for domestic purposes" is a private or non-governmental service, then proceeds to build up a theory that street railway service is governmental, following a line that applies with even greater force to public water supplies. Thus, after stating that "highways and means of intercommunication in which the whole community is interested have been from the earliest times the peculiar concern of governments," the judge turns to street railways and says: "It is impossible to conceive of the existence of the modern city of 1,000,000 or more inhabitants without some system of rapid transportation." Then, disregarding the size of the city, the opinion continues: "The street-car system of a modern city, whether its cars are operated under the surface, overhead, or under ground, constitutes the veins and arteries of the city necessary to its very life. Upon its proper functioning depends inevitably the efficiency of government in preserving the peace, protecting property and health, and preventing nuisances. Without it, the city cannot exist. Must it not be said, then, that the provision for such a street railway system, whether operated by the municipality or by private corporations, and for the regulation and control thereof, is a governmental function, and does it become any less a governmental function if the city itself operates the system instead of permitting it to remain in the hands of private persons or corporations?"

Substitute water-works for street railways and the argument is even more applicable to water-works which have been provided by states and cities since ancient Greek and Roman times, which certainly constitute "the veins and arteries of the city necessary to its very life," and without which "the city cannot exist," not to elaborate upon the applicability of the other portions of the opinion cited.

Nor is this all. In the Metcalf case decided by the Federal District Court for Massachusetts exemption was granted to Metcalf on excess income earned as an official of a water district in Maine, as also to Metcalf's partner, Eddy, as a regular municipal employee on sewerage work *(Engineering News-Record*, Oct. 9, 1924, pp. 571 and 581). But in another part of the same decision, the Massachusetts district judge accepted previous court rulings that water supply for domestic purposes is not a governmental function although for fire purposes it is such. The same precedent is accepted in the recent Detroit opinion and also in the opinion of the Solicitor General of Internal Revenue commented on and given in our issue of Jan. 15, 1925, pp. 99 and 106. It would be almost as delicate an operation as cutting out an exact "pound of flesh" to separate any modern water-works system into the portions that are for domestic supply and for fire protection. Approximations could be made by careful engineering estimates, but they would vary from city to city and checking them up would be a nice task for the district collectors of internal revenue. The least that could be done under these court opinions would be to exempt municipal employees on water-works for that part of their salary earned in preserving the capital investment made for fire protection services from that for domestic supply. Furthermore, by the rulings already cited, exemptions should not stop with the portion of service rendered for fire protection, provided and operated in part for sewer flushing, but should be extended to include sewer flushing and street sprinkling also at the very least.

It should be noted that in the part of the Metcalf opinion holding that water supply for domestic purposes is a private rather than a governmental function and in the whole of the Detroit opinion (at least as far as abstracted in our issue of July 30, p. 198) the court is dealing with sovereign powers of the state as delegated to the municipality and is falling back upon a long line of precedents for separating things done by a city into governmental and non-governmental. However necessary or useful or convenient for courts these old distinctions are, it is the height of absurdity to hold that water-works are not as essential to the public health as sewers or street railways.

Presumably this old tradition that public water supplies are private rather than governmental functions goes back to the early days when comparatively few cities had public water supplies and most of the supplies in existence were privately owned. All that rapidly changed in the United States during the 19th century and we are now in the second quarter of the 20th century when every one but precedent-bound lawyers and judges blind to progress and current facts realize that public water supplies are a vital necessity. True, the service can be rendered by private companies, but a growing conception of the importance of municipal ownership of water supplies from the viewpoints of convenience and health and the public welfare generally has led to private ownership of water-works being the exception rather than the rule. The very reverse is true of the street railway service in the United States, held in the Detroit decision to be a governmental function. In the whole country there are but a half dozen cities that own their street railways.

It is a pity that the employees of the water department of Detroit did not join with those of the street railway department there in the suit recently decided. Perhaps it would be possible for them to be admitted as a party to the suit on appeal to the United States Supreme Court. Employees of municipally owned water-works should take up the challenge of the Detroit decision and bring the real facts and issues before the United States Supreme Court. If this were done it is unbelievable that the old and narrow view that public water supply is a private function would not be upset. The issue needs deciding on grounds of much wider significance than the income-tax requirements of water-works employees, unfair as is their present situation.

Of greater importance because it affects all public servants, there is need for a United States Supreme Court ruling on whether Congress in its income tax legislation did not mean exactly what the language implies to the ordinary person when it exempted employees of municipalities, states, and the federal government. Most municipal employees are still exempt even from the claims of the most searching of the collectors of internal revenue. Why should the minority have to pay federal income taxes?

Belt Conveyors Build Wanaque Dam Embankment and Core Wall

Over 1,000,000 Cu.Yd. of Earth Fill and 77,000 Cu.Yd. of Concrete Core Wall Are Being Placed by 2½ Miles of Belt Conveyor in the Wanaque Reservoir Dams for North Jersey Cities

DAM building remarkable for both structure and methods is employed in developing the water supply of the Wanaque River for Newark, Paterson, Passaic, Clifton and neighboring communities of northern New Jersey. A main earth dam containing 830,000 cu.yd. of embankment, with a concrete core wall closes the channel of the Wanaque. At low places on the rim of the reservoir formed by the Wanaque dam, there are five other dams—two of concrete and three of earth with core walls. The three earth fills aggregate about 120,000 cu.yd. The concrete in all dams, core walls and other structures amounts to 77,000 cu.yd.—30,000 cu.yd. in the main dam. Excavation in rock reaches 40,000 cu.yd. and the earth excavation runs over 113,000 cu.yd. These are round figures, but they indicate clearly the fact of remarkable dam building.

Construction methods however are more exceptional than the dam structure. There is installed for handling materials probably the greatest footage of belt conveyors ever operated on a construction job. Nearly 2½ miles of conveyor are employed. Excavation and fill also are all-mechanical operations. So is miscellaneous haulage. Animals are not permitted to work within the reservoir site. Tractors, trailers, elevating graders, gasoline blade graders, steam rollers and steam shovels are making the borrow excavation and building the embankment. The belt conveyors and motor trucks are carrying everything. And the belt conveyors are the spectacular transportation unit.

The entire project comprises the main dam and its reservoir, the subsidiary dams, and an aqueduct and tunnel. When completed the Wanaque dam will form a reservoir 6 miles long and 1 mile wide about 25 miles north of Newark. Paterson about 11 miles southeast is the nearest city of size. The object of the new reservoir is to supplement the present Pequannock River water supply of Newark, and, as stated, to serve Paterson and other neighboring municipalities which may contract for water. Its capacity will be about 28,000,000,000 gal., giving a supply of 100,000,000 gal. daily. From the reservoir an aqueduct and tunnel take the water to Newark. The longest tunnel of the supply line, that of Great Notch, was described in *Engineering News-Record* Nov. 6, 1924, p. 744. Here there are considered only the dam structures. These comprise the main dam of the Wanaque, the Wolf Den dam, the four Green Swamp dams, intakes and gate houses, a spillway weir and channel and a portion of aqueduct including an 880-ft. tunnel. These structures are indicated on the plan Fig. 1 of the south end of the reservoir.

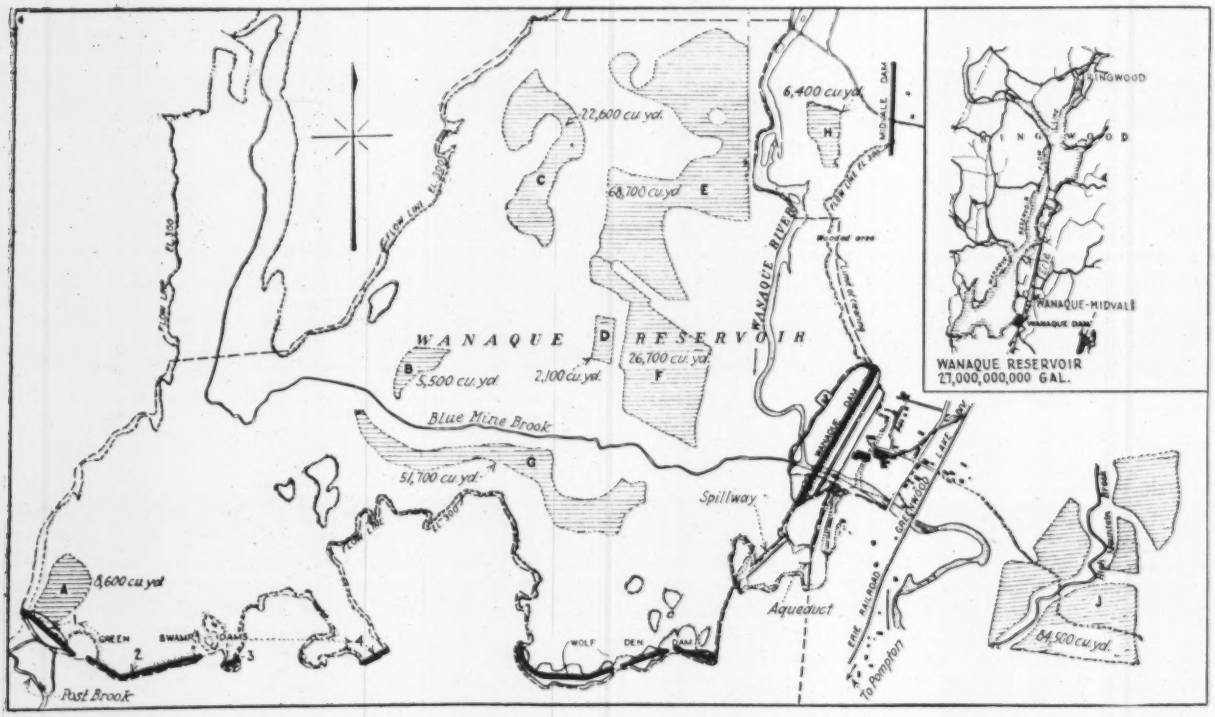


FIG. 1—LOCATION PLAN OF THE THREE WANAQUE RESERVOIR DAMS: WANAQUE, GREEN SWAMP AND WOLF DEN
Hatched areas show borrow pits from which top soil may be secured for impervious fill on upstream side of concrete core wall.

Wanaque Dam—The valley of the Wanaque crossed by the main dam is 1,500 ft. wide. The rock outcrops on both bluffs but at the bottom of the valley dips to 100 ft. below the surface, the overburden being water-bearing sand and gravel. The dam is an earth embankment with a concrete core wall going to bedrock. The lower core wall, that portion below the original valley surface, was built by separate contract and the

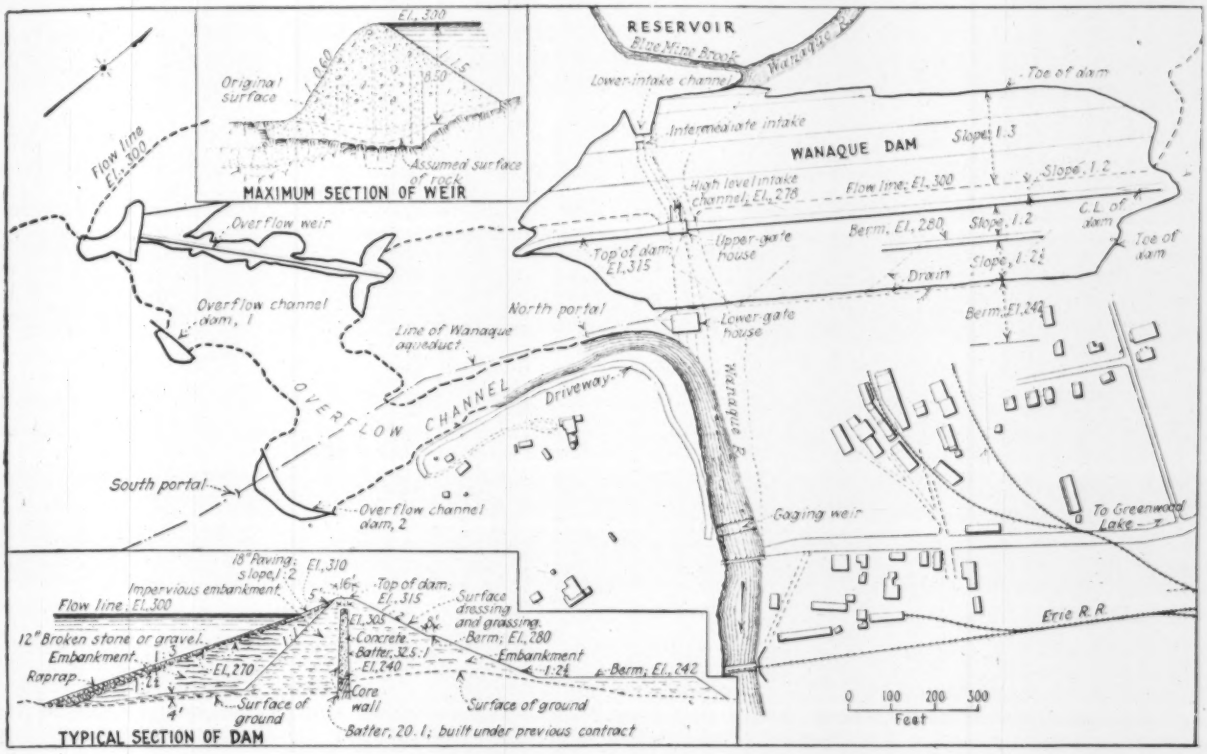


FIG. 2—PLAN AND SECTIONS OF WANAQUE DAM AND SPILLWAY

quantities of work done are not included in the figures given. The construction which involved a remarkable deep trenching operation was described in *Engineering News-Record*, July 20, 1922, p. 92. The upper core wall is a part of the present contract.

Besides the core wall there is to be mentioned particularly the impervious fill back of the wall and forming an apron upstream under the gravel fill. The downstream fill is all gravel. The crest of the dam is 15 ft. above the flow line at El. 300, and to within 5 ft. of the crest the upstream slope is surfaced with riprap and broken stone and, near the top, is paved. For the downstream slope a treatment of rock paving to simulate arches with panels of grass between has been tentatively adopted.

Spillway is provided by an overflow weir and channel around the south end of the dam. Here a ravine cuts down excavation and channel structures to a minimum. The weir is the only considerable piece of masonry. It is concrete of the section shown by Fig. 2 and has a crest length of 550 ft. A bridge for flash-board operation runs along the crest the alignment of which

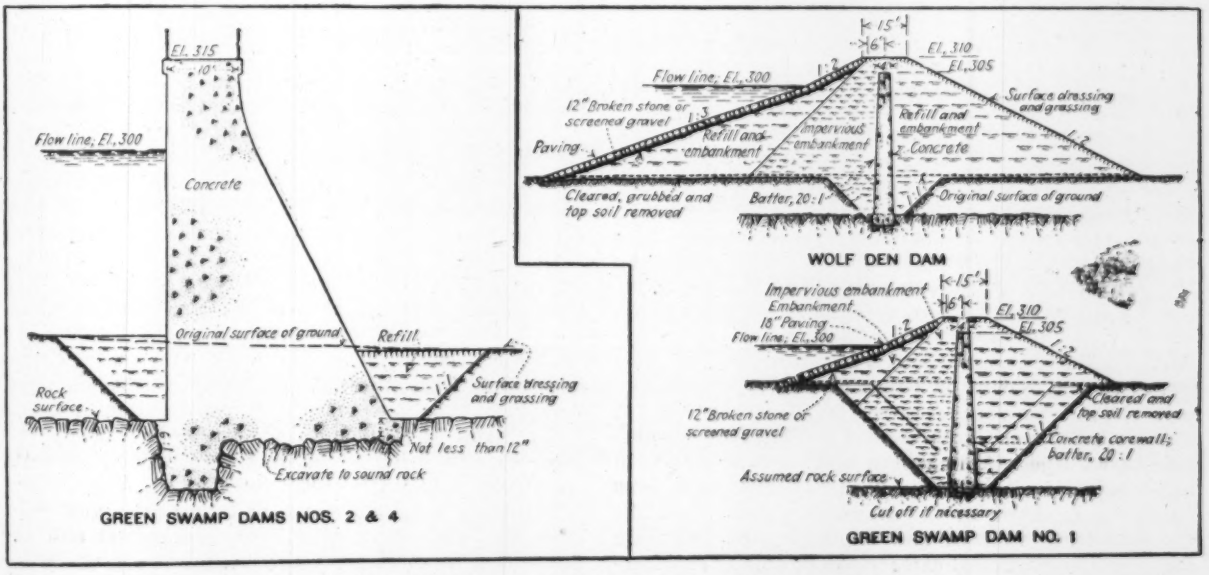


FIG. 3—SECTIONS OF SECONDARY DAMS AT WOLF DEN AND GREEN SWAMP

with the main dam and the Wolf Den dam is to be noted from Fig. 1. The aqueduct, as shown by the broken line Fig. 2, runs parallel to and crosses under the overflow channel. Here it is tunnel through rock, concrete-lined to a horseshoe section 9x9 ft. From the junction at the lower gate house to the north portal and for 600 ft. south of the south portal the construction is cut and cover concrete aqueduct.

In planning the dam consideration had to be given to stream control during construction. Two concrete conduits were built parallel to and just south of the river channel through which the stream is diverted. The dotted lines across the dam in Fig. 2 indicate the control conduits. Over them are built the intake and outlet gate houses. Their valve and penstock arrangement will not be given, but notice needs to be taken that the stream control conduits serve finally as inlets to the upper gate house and as connecting conduits for penstocks to the lower gate house. The high level inlet is paved channel coved into the upstream slope as indicated by Fig. 2. As shown, the water may be taken in at any one of three levels, high level, intermediate and lower.

Secondary Dams—The location of the secondary dams at Wolf Den and Green Swamp is shown by Fig. 1. They close low places in the rim of the reservoir and none is of great height. The Wolf Den dam, though divided by high spots into four parts, is a single structure in design—an earth fill and concrete core wall closely resembling the main dam at Wanaque. The maximum section is shown by Fig. 3. At Green Swamp four separate structures are listed. Two of these, dams 2 and 4, are gravity section concrete structures averaging 25 ft. high and altogether 1,430 ft. long. A maximum section of concrete dam is shown by Fig. 3. Only one of the earth dams at Green Swamp is of considerable size; a maximum section is shown by Fig. 3. The earth dams at Green Swamp and Wolf Den aggregate about 3,040 ft. in length and average 25 ft. in height. They are all founded on rock and have crest elevations as shown by the drawings. Away from the overshadowing volumes and dimensions of the main dam these supplemental dams would be held as considerable structures. They, therefore, entered prominently into the construction plans to be considered for the main dam.

Construction Operations

There have been given only enough details of structures to make clear the amounts and kind of construction required. It comprises chiefly excavation for dam emplacements and borrow for embankment; embankment construction and slope surfacing, and concrete construction—largely mass concrete in heavy walls. The quantities have already been indicated.

Contract Conditions—Bids for construction were received on the basis of cost plus a percentage fee. A statement of the quantities by items was made by the engineer. These figures were based on careful estimates but were stated with the proviso that increases or decreases were possible. A schedule of base unit prices was then given—a price for each of the 58 items of work. These unit prices were chosen on the basis of current market prices 30 days before asking bids and on the basis of a specified wage schedule based on actual wages prevailing on contracts for other work being carried on by the same authority. Applying the base prices to the quantities the totals were extended.

Their addition gave a grand total for Class 1 construction of $2,642,990. On this the bidder was required to name his percentage fee. Then there was added an estimated total price of $650,000 for Class 2 construction and on this a fee of 4 per cent was named.

Definition of Class 1 and Class 2 construction was broadly as follows: Class 1 included virtually all items that entered into actual construction as wages, materials, transportation, office expenses, public liability and workmen's compensation insurance, plant rental, forms and power; Class 2 included freight, traveling expenses, insurance, litigation, taxes, fees, construction or rental and removal of plant and camp buildings, railway sidings, etc., in brief all indirect construction expenses specifically included in this operation.

Provision was made for readjusting price and wage schedules, for determining equipment rental and for accounting in all details. Provision was also made for

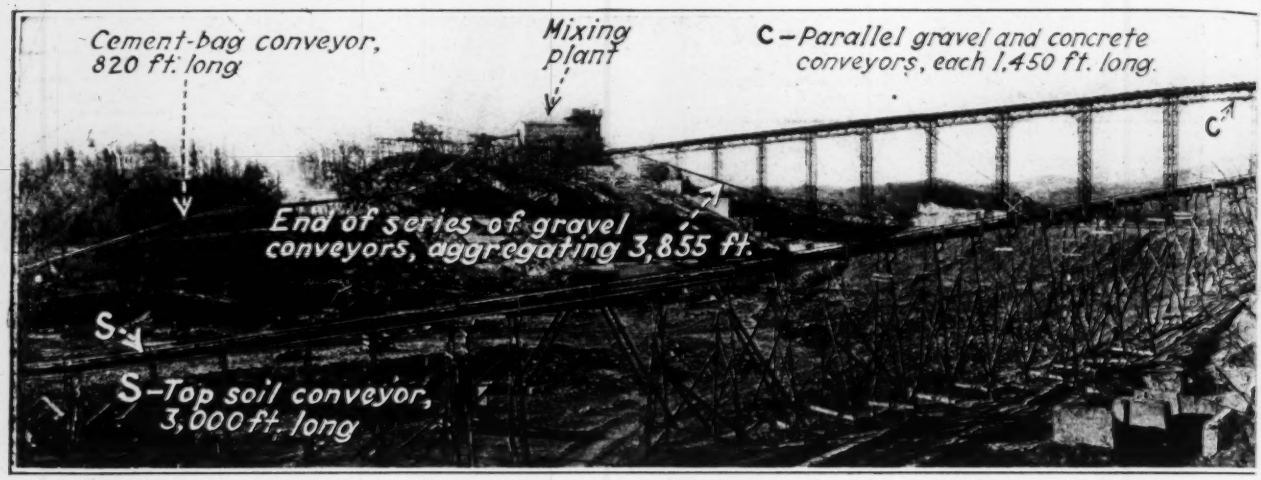

Cement-bag conveyor, 820 ft. long
Mixing plant
C—Parallel gravel and concrete conveyors, each 1,450 ft. long.
C
End of series of gravel conveyors, aggregating 3,855 ft.
S
S—Top soil conveyor, 3,000 ft. long

FIG. 4—TWO PARALLEL DISTRIBUTING BELTS ON TRESTLE

The total length of belt conveyors employed for the Wanaque Reservoir dams is 2½ miles. They will handle

reducing the contractor's compensation fee if his costs exceeded the base price and of increasing that fee if the cost was less than the base price.

Six bids were received, that of Clifford F. MacEvoy Co., with zero per cent compensation fees for Class 1 construction, being the lowest. The contract was therefore awarded at the estimated base price of $3,318,990, in March, 1924. It calls for completion by July 1, 1927.

Access and Location—Operations began promptly following the contract. Access to the main dam from the Newark-Jersey City metropolitan district is given by the Greenwood Lake Division of the Erie R.R., and well-paved highways. Near the dam is the village of Midvale with a railway station. On and below the site were the old buildings of a paper mill which was included in the property purchase for the reservoir.

WITH FEEDER BELTS FROM BOTH SIDES OF WANAQUE DAM
virtually all concrete and embankment, amounting to about 77,000 cu.yd. and 1,000,000 cu.yd., respectively.

These buildings, Figs. 1 and 2, had switch track connections with the Erie R.R. and such of them as were useful were taken over by the contractors and engineers. Virtually no additional facilities were therefore required for getting construction materials and equipment onto the job. Inter-job movement was the considerable handling problem the factors of which were location of materials and structures as shown by Fig. 1.

All the dam structures were end to end in a rough arc marking the south rim of the reservoir. Of the three groups of structures only a narrow ridge separates the south end of the main dam and spillway group from the east end of the group of Wolf Den dams. The Green Swamp dams constitute a more widely separated group; indeed their distance away and the intervening topography make them an operation distinctly apart. Therefore while an extension of the main dam handling system to the Wolf Den structures was practicable, a largely separate outfit was the logical provision for the Green Swamp operations.

Turning now to the location of materials, gravel for general embankment and top soil for impervious embankment were located, as shown by the hatched areas Fig. 1, in the valley within a mile above or below the main dam. Cement and all manufactured materials came in of course on the main dam sidings. Here again it is seen that the borrow pits so group themselves as to be tributary to the main dam and the Wolf Den dams as a combined operation while they are largely apart from the Green Swamp dams. Location of materials also influenced the selection of a combined plant for Wanaque and Wolf Den and a separate plant for Green Swamp.

Plant Selection and Plan—Concrete and earth fill made the bulk of the materials to be handled—concrete for two dams at Green Swamp and the core walls of all earth dams and fill for the earth dams. Also the fill for dams was of two kinds, an impervious bank on the upstream side of the core wall and an enveloping fill of coarse material both above and below the core wall. Except cement all materials were available locally. The whole valley bottom was gravel suitable for coarse fill and, when screened, for concrete aggregate. On certain areas top soil suitable for impervious fill overlay the gravel, but these areas were rather widely separated. The top soil quantities in any place were not large; in fact the covering varied from 6 to 36 in. and averaged perhaps 18 in. This meant the skimming of a large acreage to get the impervious embankment yardage.

In summary there were these controlling conditions to be met in plant plan and selection. Three materials, concrete, impervious fill and coarse fill had to be handled. Two of the dams—Wanaque and Wolf Den—could be considered a combination plant operation, with the dams at Green Swamp a conjoined but largely isolated operation. Location made the impervious earth haulage a widely-scattered-surface-cut, long-haul task. It had to be deposited by thin spreading. The largest of the top-soil borrow pits was across the core wall from the fill and also across a railway and a public road. Gravel was in thick deposits above the dam, but it had to be diverted three ways: for downstream fill, for upstream fill and for concrete. Wanaque embankment and core wall were the center of volume and the focus of heavy handling operations.

Several haulage plans were practicable and thought was given to railway haulage and tractor haulage. However study of belt-conveyor carriage on the Stamford water-works dam at New Canaan, Conn., led to the

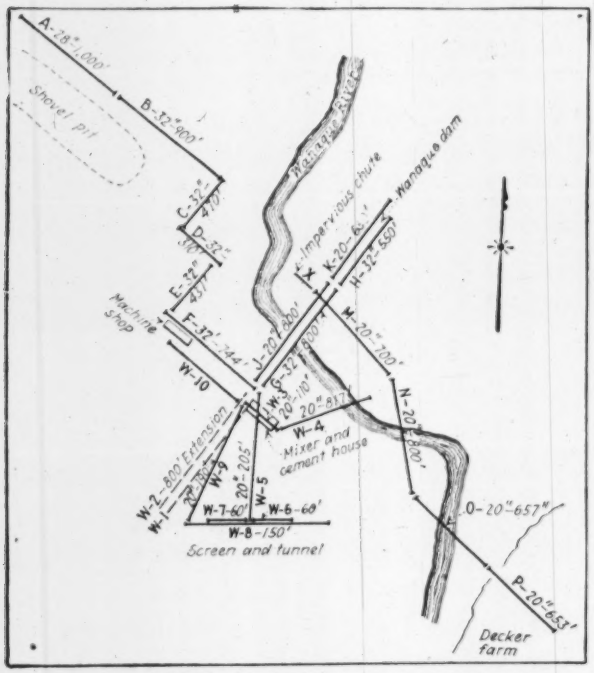


FIG. 5—CONVEYOR LAYOUT FOR WANAQUE DAM

working out of a similar plan for Wanaque by the engineers of the commission, the contractor and the Conveying Weigher Co., of New York. One system of conveyors was planned for the Wanaque-Wolf Den operation and a second for the work at Green Swamp. Similarly separate concrete-mixing plants were installed. An idea of the magnitude of the conveyor system at Wanaque is given by the joined views Fig. 4, taken shortly after installation and showing about half of the conveyor lines.

Conveyor Systems—Considering first the Wanaque plant Fig. 5, there are three sets of conveyors. One

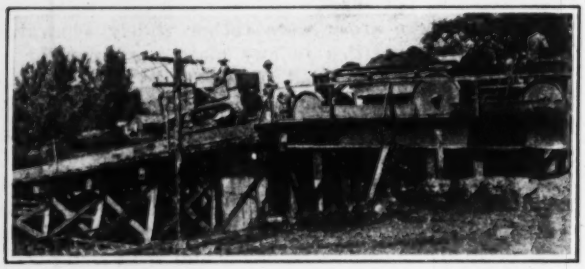


FIG. 6—LOADING RAMP FOR BELT CONVEYOR

Tractor-hauled trains of three trailers bring top-soil, loaded by elevating grader, to hopper over a short belt distributing to the main conveyor line.

set is made up of conveyors *M*, *N*, *O* and *P* reaching to the large top-soil borrow pit east of the dam. The second set consists of conveyors *A* to *H* going to the borrow pits west of the dam. This set handles (1) gravel for general embankment and (2) gravel for concrete. The third set consists of the conveyors for handling concrete materials. They are indicated on Fig. 5 as conveyors *W*-2 to *W*-10, and *J* and *K*. The plan gives the conveyor lengths and belt widths.

Conveyors *M* to *P* were exclusively top-soil conveyors. At the borrow-pit end there was a loading ramp and hopper as shown by Fig. 6. Here a 30-ft. x 30-in. conveyor took the dumped earth from a long V-hopper and

FIG. 7—CONVEYOR HANDLING TOP SOIL

When running filled, as shown, a 3000-ft. line handled top-soil at a rate of 175 cu.yd. an hour. It commonly handled about 800 cu.yd. loose measure in a day.

fed it evenly to the first conveyor of the line *P* to *M*. This line passed over the river twice on wire rope suspension bridges, under the road and the railway, and rose on trestle to pass over the core wall of the dam. Trestle construction of light round poles is indicated by Fig. 4. At the dam end the main line discharged into a 50-ft. 45-deg. steel chute with a belt in its bottom. The chute emptied into an elevated hopper for loading trucks. With the top-soil borrow east of the dam finished, conveyors *M* to *P* have been taken down and shifted to other operations. A stretch of the main line when carrying to a capacity of about 175 cu.yd. an hour is shown by Fig. 7.

On the west side conveyors *A* and *B* are mounted on wooden frames on wheels so that after a cut has been made through the borrow pit by steam shovels, the shovels are backed out and both conveyors are shifted the width of a shovel cut. With conveyor *F* the gravel is brought up 120 ft. above the river to above the dam top. At the top of conveyor *F*, the material takes conveyors *G* and *H* along the dam top and thence, by trips at any point, is chuted into the embankment. The gravel for concrete goes from the top of conveyor *F* to conveyor *W*-5 running to the screening plant.

From the screens, belts *W*-6 and *W*-7 take the gravel and sand to stock piles separated by a partition. Under the piles in tunnel is a conveyor *W*-8 which delivers

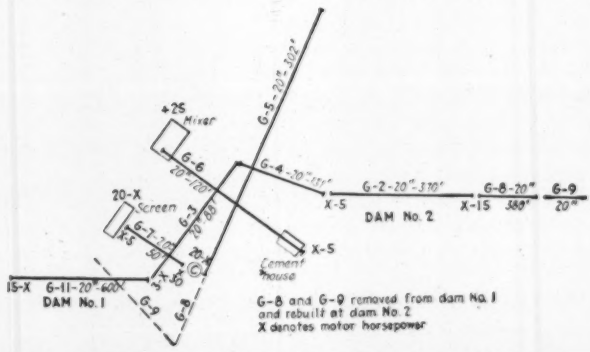


FIG. 8—CONVEYOR LAYOUT FOR GREEN SWAMP DAMS

to the inclined conveyor *W*-9 rising to the bins over the mixers. The mixer delivers to conveyors *J* and *K* along the dam and from there at any point the concrete is tripped into chutes to the core wall forms. The cement conveyor *W*-4 rises from the cement cars on

FIG. 9—ELEVATING GRADER OUTFIT STRIPPING TOP SOIL
A grader, three tractors and nine trailers formed an outfit handling 800 cu.yd. loose measure in a day.

the siding to the cement house; the cement is conveyed in bags.

Extension of the first conveyor layout at Wanaque to the spillway weir and Wolf Den structures, Fig. 1, is indicated by *W*-1 and *W*-2, Fig. 5. For the extensions, conveyors, as they finish at the main dam will be shifted to form lines *W*-1 and *W*-2. For example, conveyors *J* and *K* were mounted on frames with wheels so they can be rolled endwise into position *W*-2. At Green Swamp a separate conveyor system Fig. 8 was installed. The layout as shown is for core wall and concrete dam construction for which the gravel is being trucked from Wanaque.

Conveyor construction involved precautions but no considerable difficulty. The belts are carried either on low frameworks or light pole trestles. They dip and rise as convenient but each conveyor must keep to a straight line; if change of direction is required a second conveyor making the required angle with the first is built. This condition is indicated on the plans Figs. 5 and 8. The belts are motor operated, the motors ranging from 3 to 100 hp. depending on the length, grade and load. Fig. 8 shows the motor horsepower for each belt. About 100 hp. was required to operate the conveyor line *M* to *P*, Fig. 5. The speed of operation generally is about 400 ft. a minute. Reasonably steep grades are negotiated by some of the belts. Conveyor *M*, Fig. 5, handling top soil, had a rise of 20 deg. The cement conveyor *W*-4 had a grade of 44 per cent., and several of the sand and gravel conveyors had graders of 25 per cent.

The conveyor lines along the Wanaque dam were the most particular in construction. They were mounted on frames on wheels and the concrete conveyor was housed in to conserve the heat of the concrete in winter work. The trestle construction of steel met several requirements, besides furnishing a track for the conveyors. The towers buried in the core wall provided a reinforcing element. They provided supports for moving and setting the core wall forms and they gave attachment for booms carrying chutes for placing gravel fill.

Excavation—Excavation for the dam emplacements involved only the usual methods of removing earth and rock. The borrow pit excavation for constructing embankment required two types of operations—stripping top soil for impervious fill and digging gravel for the main prism of the dam. Top soil removal was the special operation and precedure on the borrow pit east of the dam was as follows:

The top soil overlay gravel and had to be removed unmixed with gravel. It had a growth of bushes and grass and these were cleared, the large roots were grubbed out and the grass roots worked over by gang plows and harrows hauled by tractors. Elevating graders then dug the top soil and loaded it into 120-cu.ft. bottom-dump trailers hauled in trains of two and sometimes three by tractors. The digging and loading operation is shown by Fig. 9. When loaded the trailer trains ran to the loading ramp, Fig. 6, and were unloaded. Three tractor trains kept the grader busy. With two men on the grader and one on each tractor and with three men at the loading ramp the outfit handled about 700 cu.yd. place measurement in an 8-hour day. Top soil removal from the borrow pits west of the dam was also by elevating grader, material being directly truck or tractor hauled to the fill.

Embankment Construction—To build impervious embankment, the top soil coming from the conveyors is distributed by five motor trucks. It is then spread by motor graders, sprinkled and rolled. On the first part of the work, when conveyor line *M* to *P* and trucks

FIG. 10—PLACING IMPERVIOUS FILL BEHIND CORE WALL
Outfit comprises five 4-cu.yd. motor trucks, three motor graders, two steam rollers and one sprinkler wagon placing 1500 cu.yd. a day.

from the west borrow pit were delivering, three motor graders, two 10-ton rollers and one sprinkling wagon placed 1,500 cu.yd. loose measure in an 8-hour day. The view Fig. 10 shows the placing outfit in operation.

Coarse fill is all delivered by conveyors *A* to *H*. The digging is by steam shovel and the placing is by flushing with water through chutes. A chute outfit is shown by Fig. 11. The belt along the dam trips into the chute hopper to which flushing water is admitted in a 4-in. stream. The water supply is from the river where an 8-in. suction 6-in. discharge centrifugal delivers 1,200 gal. a minute to a 1,460-ft. 12-in. pipe line along the trestle. The lift to the trestle line is 103 ft.

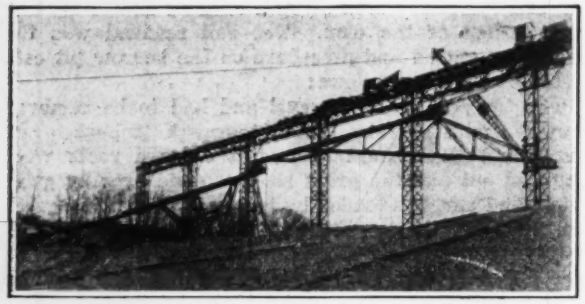


FIG. 11—CHUTE PLACING GRAVEL FILL AT WANAQUE
Gravel delivered by belt conveyor on trestle is tripped into chute hopper and flushed into fill with a 4-in. stream of water.

through 300 ft. of 15-in. pipe. A 100-hp. motor operates the pump.

Concrete Construction—As stated the mixing plants form the centers of the third group of belt conveyors, those for handling cement, sand and gravel and for delivering mixed concrete to the core wall and dam structures. There are two outfits of which that at Wanaque is the greater. Its arrangement and equipment are shown by Fig. 12. At Green Swamp there is a four-story mixing plant consisting of bins, measuring floor, mixer floor and chute and conveyor floor. The mixer is a one-yard machine. At this plant bank run aggregate is brought in motor trucks from the gravel borrow pit and conveyed by belt to a crusher and screen. A derrick and clamshell places the screened sand and stone in the mixer bins. A 5x8-in. triplex pump and a 1,500-ft. pipe line furnishes the mixing water. This pump has 3-in. suction and discharge and is operated by a 7½-hp. motor.

All concrete was proportioned by the Abrams method considering 105 lb. of cement a cubic foot. The requirements for mixing, compacting and forms were those usual for first-class concrete. The manner of handling by belt conveyor was the only thing of particular note. The diagram Fig. 12 shows the journeys by belt and the various handlings of cement and aggregate. Some of the belt grades deserve attention. From the mixers the concrete goes onto the 20-in. concrete belt on the core wall trestle and from here, at any point

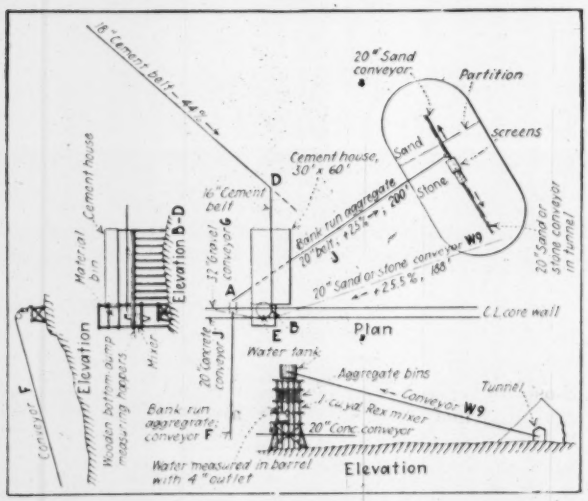


FIG. 12—CONVEYOR SYSTEM FOR AGGREGATE AND CONCRETE AT WANAQUE DAM

along the dam, it is tripped to chutes going into the forms.

Core construction on the main dam is well shown in the cover picture. On parts of the work at the beginning wood forms were used. The regulation form is however a traveling steel form 100 ft. long and 16 ft. high with the walls 9 ft. apart. On the secondary dams both the gravity sections and the core walls were built with wood forms. The belt conveyor for delivering concrete as shown by Fig. 13 is generally like that on the main dam, but is carried on a pole trestle parallel to the concrete structure.

Discussion—The belt conveyor as a method of handling materials has disclosed real merits on the Wanaque reservoir operations. Mechanically it is reasonably easy to install; only a light carrying structure is required; care and operating attendance do not call for a large force. The belt operates well on steep or undulating grades, which simplifies location and does away with supplemental hoisting equipment where

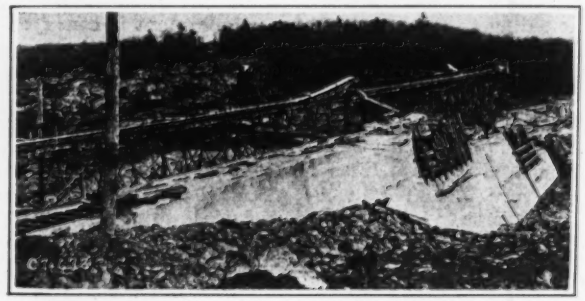


FIG. 13—CONVEYORS BUILDING CONCRETE DAMS AT GREEN SWAMP

materials have to be elevated. Little difference in efficiency is shown in conveying fine earth, coarse gravel and wet concrete. Delivery is possible at any point by installing a trip there; this is particularly a merit in delivering to a long core wall and embankment.

A force of about 500 men is engaged in all operations. Means are provided for housing and feeding such of these employees as desire to live on the work. As of July 15 the state of progress on the work was in round figures about as follows: Earth embankment; general, 115,000 cu.yd.; impervious earth embankment, 115,000 cu.yd.; concrete, 43,000 cu.yd.

The Wanaque water supply is being developed by the North Jersey District Water Supply Commission with headquarters in Newark, N. J. Morris R. Sherrerd is consulting engineer, Arthur H. Pratt is chief engineer, N. C. Holdridge is assistant chief engineer in direct charge of the Wanaque reservoir operations and Arthur L. Sherman is designing engineer. Clifford F. MacEvoy of Newark is the contractor with O. H. Kellogg superintendent.

Belgian Companies to Build Greek Railways

A group of Belgian banks and construction companies has submitted a proposition to the Greek government for the extension of the Greek railway system and the equipment thereof with rolling stock. The length of line to be built will total 350 km., including a line from Salonika to Drama and Cavalla, the extension of the line from Missolomghe to Arta and Janina in Epirius and ultimately to the Adriatic shore, and finally a spur joining the systems of Macedonia and Epirius.

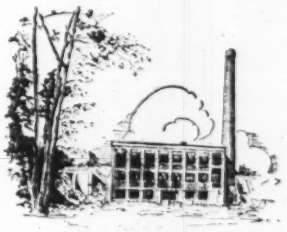
Engineering in the Small City

A series of notes from the field on the Problems and Practices of the Municipal Engineer in the Cities Below 100,000

The Editor Visits the City Engineer

Snapshots of Our Representative Small Cities

Brookline, Mass.



INCINERATOR, BROOKLINE, MASS.

A TOWN IN NORFOLK COUNTY, MASSACHUSETTS, 3 miles southwest of Boston; includes villages of Cottage Farm, Longwood, Coolidge Corner and Reservoir. Brookline is a residential suburb of Boston; several attempts have been made to annex it to Boston but annexation has never been made. Town settled in 1635 and called Hamlet of Muddy River; in 1705 named Brookline. Pop. 1924, 37,748.

THOUGH there are several details in the engineering administration of Brookline, Mass., which should be given special discussion, this fact is outstanding; all of the engineering work for the entire town, no matter what department or bureau, is done under the supervision of the town engineer. "We do everything" might very truthfully be the slogan of his office force. Henry A. Varney is the town engineer, and his is a job concerned not merely with design and construction of water-works installations, sewers, sidewalks and streets, but if a traffic signal is wanted he supplies it. If the forestry department which, incidentally, cares for all roadside trees of which there are a great number, wants any engineering work done, or the department of parks requires any landscape engineering or a service building designed or built, or the planning board wants data and plans for zoning, Mr. Varney is called upon. The diversity of his responsibilities is reflected in his office and field organization, and the appropriation necessary to carry his force. He has an engineering staff of 18 men and his annual appropriation for salaries and office expense is about $40,000 yearly.

Brookline is a town. It holds town meetings, a set annual meeting and as many special meetings as are deemed necessary. Instead of all the electors now having a vote on public matters (there are probably 20,000 electors among its 45,000 of population) the official voice of the electors reposes in a representative body composed of 27 members from each of nine precincts. The board of selectmen is the chief administrative body, and the chairman of that body corresponds to the mayor found in most smaller municipalities. The town engineer and the superintendent of streets both are appointed by the board of selectmen. Mr. Varney has been town engineer for the past ten years, though he has been in the town engineering department ever since it was organized. M. Driscoll has been superintendent of streets for half a century.

Brookline is not an industrial town. It is almost entirely residential, for it lies within the limits of greater Boston. The latter fact imposes certain problems which cannot be considered as belonging to Brookline or Boston alone, but must be of mutual concern. For instance the sewers are a continuous system. Brookline is served by the Metropolitan sewerage commission, though it makes and pays for its own installations. But where a new sewer is to be constructed by either municipality, proposed drainage area maps are interchanged and each designs its sewer to carry the load of its own and that of its neighbor in the interconnected line. A sort of gentleman's agreement exists, so that in matters of sewage disposal a complete mutuality of interest governs.

Brookline has an area of 6.81 square miles, about one-half of which is built upon, the other half being composed of large estates. The town is hilly, elevations ranging from 17 to 340 ft. above mean sea level. Street widths are mainly 50 ft. though some are 40 ft. and there are several 80 ft. wide. Beacon St., which halves the populated section of the city, is from 160 to 190 ft. wide, with double-track trolley lines and trees in the center section, and roadways, flanked by parking strips.

Street Engineering—Since the town is residential, two problems have been emphasized: street construction and opening up of new homesite property. And it can be said that in Brookline pavements are not laid, but designed and constructed with as great a precision as a much more intricate engineering structure. The first step in this design of roadways is the accumulation of grade and alignment data for each street. This is done at odd times by the field staff. The method of getting this information is as follows: The alignment of each street is carefully made and levels are taken along both curbs at 25-ft. intervals throughout its entire length. At intersections readings are taken with greater frequency. All this information is then plotted on maps of a universal scale of 20 ft. to the inch. Maps of streets not contemplated for immediate improvement are also made at odd moments, so that urgent work is never interfered with. When the surfacing of a street is to be undertaken the map showing this street and the profiles of the street are brought from the file and taken into the field, where iron pins are set at the 25-ft. intervals, the street cross-sectioned, generally at both quarter points and at the center, and profiles made of each of the cross-sections. The assistant engineer then makes a special study of each intersection. He gets on the ground and readings are taken every few feet around each curb first at the curb line and then in a direction normal to the curb and at a distance out corresponding to the axial position of an automobile turning that particular corner. The two considerations in establishing finish grade for intersections are the ease of the vehicle in turning the corner and perfect drainage. Readings are then taken along the crown of the intersecting street, and the three sets of readings—those in a direction of the intersecting streets and those normal to both curbs around the curve—are harmonized to satisfy the two conditions mentioned above. Grades are then established at all of these points, iron pins are set and string run at grade of the finished subgrade from pin to pin in all directions. Since bitulithic is used mostly in new work, if the sub-

grade is perfect as to grade, there will be less difficulty in perfecting the grade of the finished surface. With such precision it is easy to see why not a drop of water is to be found at newly improved intersections.

Another noteworthy detail of street improvement is the fact that stationing is carried along the curbs or at an offset, and the points of curvature and tangent at each curb become a permanent station from which both alignment and elevation can be picked up during any part of the improvement.

The total lack of rectangularity in the street layout of the town, together with the fact that so much new estate property is being sold in building lots, imposes another problem upon Mr. Varney.

Until recently there was no authority vested in any city department or individual whereby grades or alignment of newly-opened territory had to meet city requirements. Recently, however, there has been vested in the board of selectmen the power of a board of surveys. This board requires, within certain limits, the harmonizing of new streets to existing ones in the matter of line and grade before the newly-surveyed plot is recorded. The board cannot arbitrarily fix such limits, but usually strikes a mean between the wishes of the property owner and the recommendations of the town engineer, if there is a wide divergence between them. The study of these new developments and the consequent recommendations take up not a little time of the town engineer. The hilly character of the town complicates the problem considerably.

The City Water—Brookline's water supply is obtained from driven wells and underground collecting galleries located on the banks of the Charles River in the West Roxbury section of Boston, and at a distance of about five miles from the center of Brookline. Low-lift pumps located at the collecting galleries raise the water to the purification works through which it returns by gravity to the pumping station and is thence pumped to the low-service distribution mains and equalizing reservoirs. High-service supply is taken from another station by intermittent pumping from the force mains into the distribution system. The supply is secured through 175 wells, 2½ in. in diameter and from 40 to 90 ft. deep, which deliver through cast-iron pipe lines to the suction header of the low-lift pumps. The collecting galleries are 4 ft. wide and 2 ft. high and 490 and 240 ft. long, respectively. The walls are of stone without mortar and are arched with brick. A 12-in. pipe delivers water from these galleries to the suction header. The supply secured thus is about 5 m.g.d. In dry weather the supply may be augmented by irrigation: the low-lift pumps draft from the river and discharge on gravel beds over wells and galleries.

The purification works consist of a control house, six tricklers, sedimentation basin, six filters and a clear-water reservoir. The supply is received from the low-lift pumps through a 24-in. line and is returned to the low-service pumps through a pipe of like diameter. Piping is so arranged that any part of the purification plant can be bypassed for repairs or cleaning. The sedimentation basin has a capacity of 533,000 gal.; the clear-water reservoir of 6 m.g. The filters are of the slow sand type with a rated capacity of 1.6 m.g.d. each.

Diversified Duties—Though Brookline maintains an incinerator, which by the way was designed and built by Mr. Varney, capable of burning garbage as well as other refuse, only combustible refuse is handled.

Engineering Work

Garbage disposal is under the department of highways, and the cost is paid out of the health department appropriation. It is interesting to note that a contractor pays the city annually $2,000 for the privilege of maintaining a force at the incinerator to pick over the combustible refuse. He has found the enterprise quite profitable, and a visit to the plant explains the reason why. Brookline is a rich community which replaces wearing apparel and furnishings often.

The manner in which engineering records are kept could well be copied by municipalities of much larger size. Every original is kept on file in a vault, and every map, tracing or blueprint, field book, estimate of work to be done, computations made in making the estimate, in fact every valuable bit of information is filed and referenced, and a card index kept of it. This method will be described in a separate article.

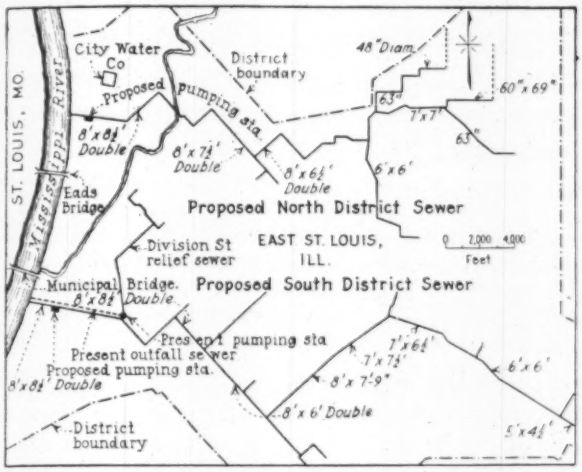
Though it is apparent that Mr. Varney could have his time well occupied with the larger engineering problems, the twelve hours that he actually works daily is scarce enough time for his manifold responsibilities. Perusal of any of his annual reports to the board of selectmen shows their significance. These are found under miscellaneous: plan submitted for transfer station with central island for improving Chestnut Hill situation; great deal of study given traffic signals; plans and photographs made for the police department in accident and other cases; plans and data prepared for suits brought against the town in connection with street accidents; data prepared at request of committee appointed to study the town's finances; plans, descriptions and photographs made for the building department in connection with suits by and against the city; blueprints made for citizens asking for data on land subdivisions, etc.; large display plans made for town meetings and those of the planning board; chain-link fence erected around the cemetery; monument replacements; house numbers checked up and new ones assigned, etc. And even this list but touches upon his miscellaneous duties.

Enlarged Sewer System Needed at East St. Louis, Ill.

PLANNING a comprehensive extension of the sewer system at East St. Louis, Ill., is complicated by the fact that the city is on river bottom land, protected against high water in the Mississippi River by levees on three sides and protected against storm runoff from high bluff land by a levee and ditch on the east side. Thus, all sewage and drainage water within the protected area has to be handled by pumps during periods of high water. From a recent report to the city by Black & Veatch, consulting engineers, Kansas City, Mo., it appears that with a present population of about 78,000 on an area of 14,395 acres (including 6,700 population and 6,110 acres in suburbs outside the city limits), the population in 1960 will reach 300,000 or a density of about 19.5 persons per acre. The report also shows that to meet the prospective needs of the city and its adjacent area an outlay of about $8,500,000 would be required.

Conclusions presented in this report are to the effect

Of the Small City



PROPOSED TRUNK SEWERS FOR EAST ST. LOUIS, ILL.

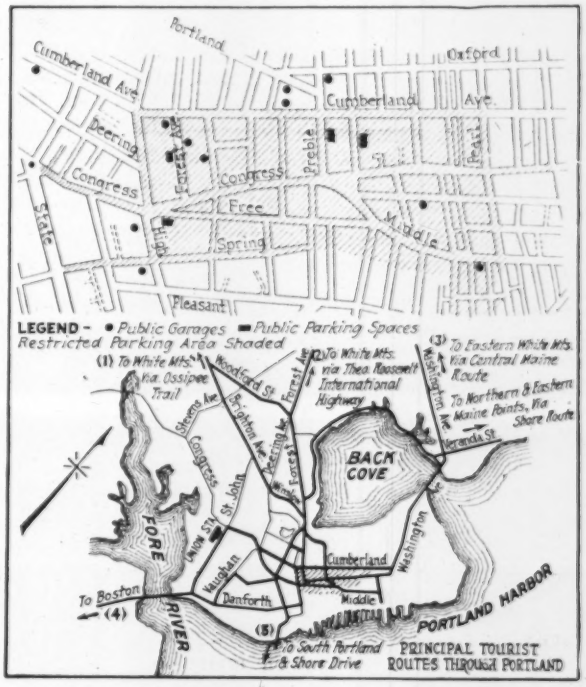
that the present sewerage system is adequate for the sewered districts and as an outfall for additional sanitary sewers but not for additional storm-water runoff. Within thirty years, owing to growth of population, intercepting sewers will be required to reduce the area served by the present system, while two trunk sewers with separate outfalls and pumping stations will be required within the same period to serve north and south districts which probably will then be included in the city. In the north district, the storm sewer problem hinges on the construction of the Cahokia Creek cutoff for the East Side Levee and Drainage District. This cutoff, as recommended some years ago by Alvord & Burdick, consulting engineers, Chicago, would be an open channel or closed conduit extending west across the north end of the city from the drainage canal under the bluffs to a pumping station at the Mississippi River.

Within four or five years a relief sewer along Division St. to the river will be necessary to serve the downtown district. Sanitary sewers are needed in all the new districts to be served and this need is greater than that for storm sewers. The stockyards and some of the meat packing plants have private sewers, and some of the outlying suburban districts have their own sanitary sewers, but these last are inadequate as part of a comprehensive sewer system. Owing to the flat grade and low headroom, sewers larger than 30-in. diameter would be either of rectangular section or with a segmental arch on an invert.

Two principal recommendations are: (1) Two combined trunk sewers for the north and south districts, to serve all unsewered areas that may be taken in during the next thirty years, these sewers to be constructed in sections as needed; (2) sanitary sewers for certain built-up districts largely outside of the city limits, the sewage to be led to pumping stations for discharge into the present combined sewers. The estimates of cost are $4,000,000 for the north district, $3,528,980 for the south district, $691,000 for the sanitary sewers and $320,000 for the Division St. relief sewer. No action has been taken by the city in regard to adopting or carrying out the recommendations of the report. W. McK. Brown is city engineer.

Controlling Automobile Parking in Portland, Maine

AFTER having tried various methods of controlling parking privileges in the city of Portland, Me., the city manager devised a system of painting curbs to denote areas where parking was permitted or forbidden. Within the past few weeks the regulation has been put in force whereby certain areas are indicated to be "no parking," "fifteen-minute" and "one-hour" parking spaces. Where no parking is allowed the curbs are painted black and white, in alternate strips, the strips



PARKING AREA IN PORTLAND AND ARTERIAL ROUTES

Via the arterial routes the following places are reached:

(1) Ossipee Trail—To White Mountains, Lake Winnepesaukee, Sebago Lake, Westbrook.

(2) Theodore Roosevelt International Highway—To White Mountains, Freyburg, Bridgton, Naples; and Allen Ave. Road—To Gray, Poland Spring, Lewiston, Augusta, Rangeley Lakes, Belgrade Lakes.

(3) Central Maine Route—To Gray, Poland Spring, Norway, Paris, Eastern White Mountains, Lewiston, Augusta, Belgrade Lakes, Rangeley Lakes, Bangor; and Shore Route—To Brunswick, Augusta, Bath, Rockland, Bangor, Lafayette, National Park and all Northern and Eastern Maine Points.

(4) Shore Drive—To Boston, Portsmouth, Biddeford, Sanford, Kennebunk, Old Orchard; and

(5) To South Portland, Cape Elizabeth.

being perpendicular to the street axis. Where cars may be parked for fifteen minutes the curbs are painted white; and for one-hour parking, yellow.

Considerable publicity has been given the new regulations by the local press, and tourists are given small-sized maps showing both the restricted area and the arterial trans-city streets. As Portland has an irregular shore line and more or less irregular topography, these routes are rather difficult to follow without such assistance. Small pamphlets containing traffic suggestions and the city's ordinance concerning traffic are also given wide circulation. The pamphlets, containing a digest of the motor-vehicle laws of the state of Maine, are circulated outside the city, particularly on those highways, and at stopping places along them, where tourists entering the city are most likely to travel.

Foundation Under Settling 175-Ft. Chimney Reinforced

Reinforced-Concrete Cantilever Ring and Heavy Girder, Supported on Wooden Piles—Unique Method Used in Guying

By Wilmer Z. Kline
Associate Civil Engineer, U. S. Navy Department, Philadelphia, Pa.

DUE to unstable soil conditions existing in a portion of the Philadelphia Navy Yard, the foundation of a 175-ft. chimney located in that portion of the yard settled considerably over a period of several years. The settlement was uneven, one side settling at a greater rate than the opposite side with the result that the chimney was tilted from a true vertical position. To correct this tilt, a new foundation, consisting partly of a ring under the edges of the old foundation and partly of a new reinforced-concrete girder passing under the old foundation, was constructed. This new installation, together with the manner in which the chimney was guyed during reconstruction have several interesting features.

The chimney is a radial block chimney 175 ft. high above foundation top. The outside diameter is 18 ft. 8 in. at the bottom and 13 ft. 6 in. at the top. The shell is 2½ in. thick at the bottom and 9 in. at the top. The chimney rests on an octagonal concrete foundation 27x5 ft., supported by 64 concrete bulb piles intended to carry 30 tons each.

The soil for a depth of 77 ft. consists entirely of river silt, which in places appears to act in some respects as a fluid, principally because of its water content. Firm strata, consisting of sand, some gravel and a tough red clay, exist at a depth of about 77 ft. below the surface of the ground.

The foundation and chimney were erected in 1918. It was not until a year later that any movement was discovered. At that time it was found that the sheet metal protection of the smoke breeching on the power house immediately next to the chimney was buckling and upon examination the chimney was found to be leaning. The center line of the chimney is 14 ft. south of the power house wall.

Settlement measurements were begun Nov. 6, 1919, and continued through to May 31, 1923. During this time there was a total subsidence on the north side of 0.593 ft., on the south side of 0.506 ft., on the east side of 0.570 ft., and on the west side of 0.503 ft. The tendency of the average monthly settlements to decrease might have indicated that the foundation eventually would have brought up of its own accord, but studies of other settlement conditions in the vicinity indicated that this bringing up would not occur, at least not until the point of the safety had been passed. Transit measurements indicated that the maximum horizontal movement at the top of the chimney amounted to 17.02 in.

Thus with a lean of about 17 in. to the north, the chimney was not considered unsafe even with a strong wind from the south acting upon it. However, the tilting constantly increased and as stated before, studies of settlement of this and other structures indicated that the settlement and the tilting would increase indefinitely. Construction of a new independent foundation south of the existing one and the re-erection of the chimney on this new foundation were considered but discarded because of greater cost over the scheme finally adopted. This consisted of leaving the chimney and old foundation practically untouched and underpinning it. In order to stop future settlement entirely it was considered necessary to carry the load from the new foundation to the hard strata 77 ft. below grade.

Inasmuch as the power house interfered, the ring could not be placed under the old foundation for the complete perimeter. Therefore, a girder carried the load on the power-house side. This girder was 50 in. wide and required an effective depth of 70 in. with the customary stresses of 16,000 and 650 lb. per sq.in. for steel and concrete, respectively. The 50-in. width was chosen for the reason that the old pile spacing in a direction parallel to the lean was 25 in. Piles in the row along the center of the beam were removed to allow this beam and its reinforcement to pass under the old foundation.

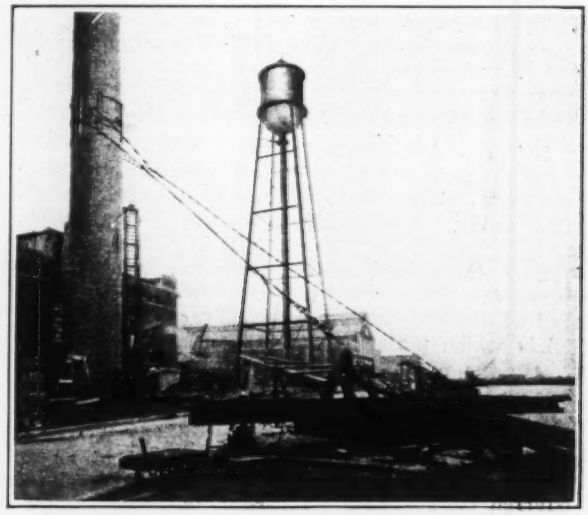


FIG. 1—GUY LINES ATTACHED TO CHIMNEY
Note that the anchor rails are lifted from the bed upon which they were originally placed by the 17.75-ton pull in the guys.

Work on the underpinning was started at the end of May, 1923. The area to be occupied by the new foundation was excavated and guy lines were installed. Because the new work under the old foundation was more severe under the north side, and because the lean was to the north, guying of the chimney was from the south exclusively. In view of the disturbance around the old foundation which the new construction work would cause, it was decided to put a definite pull on the guy lines, thereby throwing the center of pressure of the chimney to the south side of the old foundation. Two guy lines were used, one strung in a southwest and the other in a southeast direction. They were so located that the resultant pull from an equal load in each guy was in a north and south direction. Guys anchored to dead ends were not used. It was thought best to use a system whereby the load on the north side caused by the lean to the north would be exactly neutralized.

In order to apply this pull to the chimney without causing any damage to it or overloading the north side, a saddle of ten 6x10-in. timbers, each about 10 ft. long, was fastened to the chimney by wire rope bands. The

guys were slung around this saddle, each line being independent of the other. One guy consisted of 1-in. wire rope of six strands, 37 wires each, and the other 1¼-in. wire rope, six strands, 19 wires each, these being the sizes that were readily available. The anchorage used consisted of a wood frame loaded on the rear end and swinging free around a fulcrum at the front end. The load was finally placed in the guy line by jacking up the rear of the anchorage, thus putting slack in the line. This slack was taken up with a turnbuckle. The jacking was then repeated, more slack taken up and the process continued until the rear end of the platform hung free.

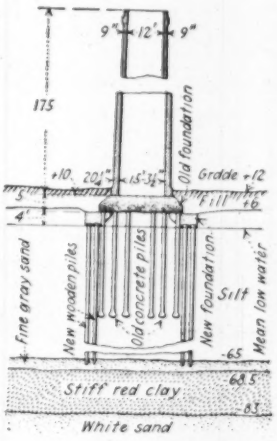


FIG. 2—SECTION THROUGH CHIMNEY AND FOUNDATION

The area to be occupied by the new foundation was excavated and this annular excavation was sheathed and the excavation within it made before any piles were driven. Straight pine piles were used. Their length ran from 70 to 75 ft. Average penetration was 78.5 ft. below grade, the maximum being 88 ft.

After the excavation was made concrete piles were cleaned and washed down. Bearing out the belief that the concrete piles were not faulty and that soil instability was the cause of the chimney subsidence, it was found that with one or two exceptions the bodies of the piles were of full circular section without depressions or deformations.

The top of the new concrete was kept about 3 in. below the bottom of the old foundations, the load being transferred by grouting the intervening space. Side forms were used under the old foundations for the girder but omitted for the ring foundation.

As strengthened, the chimney is 11.25 in. out of plumb but is not considered unsafe. Observations subsequent to the reconstruction methods indicate that the subsidence has been practically stopped.

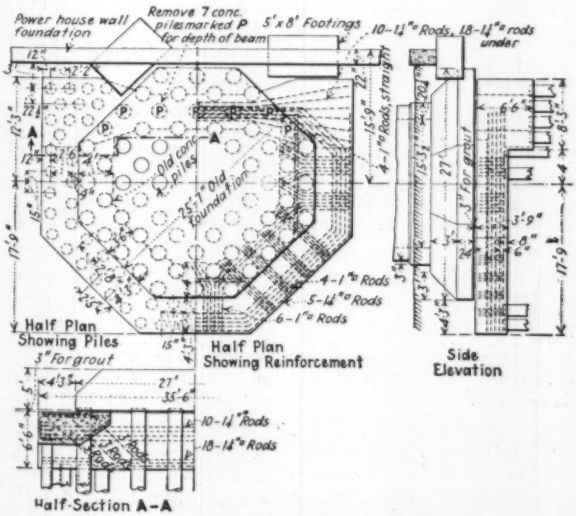
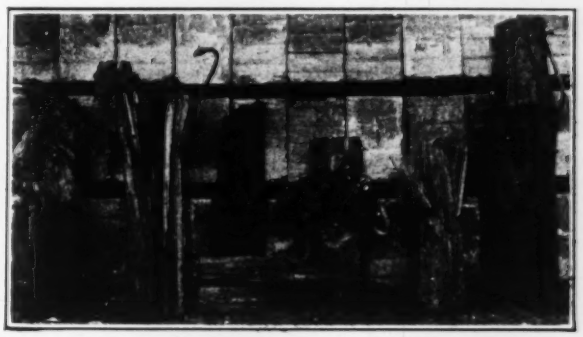


FIG. 3—SECTIONS OF NEW AND OLD FOUNDATIONS

The work was performed by the Triest Contracting Corporation, of New York, under a government contract, the total cost of which was $17,034.09. Work was under the direction of the Bureau of Yards and Docks of the Navy Department, Rear-Admiral L. E. Gregory, Corps of Civil Engineers, U. S. Navy, being chief of the bureau. Rear-Admiral F. R. Harris, Corps of Civil Engineers, U. S. Navy, was public works officer of the Fourth Naval District, and the writer prepared the design of the new foundation and accompanying work and attended to the carrying out of the adopted scheme in the field, acting under his direction.

Wooden Piles Badly Broomed at Splices

WHAT frequently happens to spliced piles in hard driving is shown clearly in the accompanying illustration. These piles were driven under the foundation mat of the power house of the Portland Electric Power Co. at Portland, Ore., when the building was built some years ago. At that time a number of the piles had to be spliced to obtain the proper penetration. Recently, when it became necessary to replace the upper



PILE SPLICES DAMAGED BY OVERDRIVING

portions of all the piles, under the building, the splices were all exposed (*Engineering News-Record*, May 28, 1925, p. 888). The piles shown are typical examples of the damaged splices found. The material through which the piles had been driven was a coarse gravel where driving was hard and the rate of penetration irregular.

Northern Pacific Ry. Opens Coal Mine

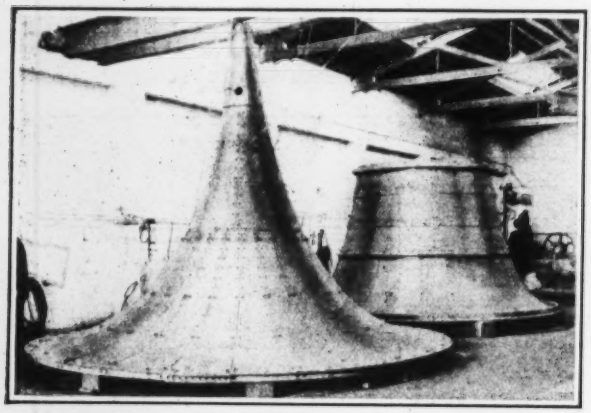
An open-pit coal mine at Colstrip, about thirty miles south of Forsyth, Mont., has been opened up by the Northern Pacific Ry. through the Northwestern Improvement Co. The operation of the pit is being handled by Foley Bros., general contractors, St. Paul, Minn., who have in use a large dragline excavator stripping the first cut, and a large shovel loading the coal direct from the vein into the railway company's gondola cars. This equipment is electrically operated and switching is done by two of the largest storage-battery electric locomotives yet put into operation. The stripping cut is about 8,000 ft. in length, with an overburden of 20 to 40 ft. The full coal vein is 28 ft. thick and covers an area of several hundred square miles. At the present time about 2,000 tons of coal per day are being loaded.

Steel Draft-Tube Liners Used as Concrete Forms

Complicated Wooden Forms Eliminated—Plates Anchored to Concrete—Steel Framework Used for Cone

IN DESIGNING draft tubes for the waterwheels at Pit 3 power house of the Pacific Gas & Electric Co. in California it was decided not to use the usual wood forms for concrete either in the bell of the draft tube itself or in the cone within the draft tube. Instead, a bell and a cone were made up of steel plates and were placed in such a way that they served first as forms for the concrete and then as liners to give the concrete a smooth surface.

The power-house foundations were first poured up to the level of the draft-tube floor. A heavy wooden staging was then built, set accurately in place and the bell or draft-tube lining was assembled on this frame and riveted. Anchor bolts tapped into the shell of this



BELL AND CONE ASSEMBLED BEFORE SHIPMENT TO THE JOB

bell were hooked over reinforcing bars in the surrounding space which was then poured full of concrete, the riveted steel plates serving as forms in shaping the draft tube as desired.

When the concrete in the bell had hardened the wooden staging was removed and the central cone was assembled in place. The cone is bolted around the circumference of its base to an anchor ring bolted into the draft-tube floor. A central framework of steel upon which was mounted the circular splice plate for the main horizontal joint in the cone served as a support during construction and later as a bond between concrete and steel. The top of the cone was finished off with a cast-iron tip furnished by the turbine manufacturer, bolted in place and poured full of concrete, this tip being put on after the entire central cone had been filled with concrete through the top.

The bell or draft-tube liner consists of 24 strips of ⅜-in. steel plate arranged as shown in the accompanying illustration. Butt joints were used exclusively and the strap over the joints on the side away from the water was made wide enough to develop full strength in two lines of rivets, one at either side of the joint.

In the cone, 12 conical-shaped pieces of steel plate were used in the upper part and 26 strips in the lower portion. The latter are 8 in. wide at the top and 29 in. wide at the bottom.

Both the bell and the cone were riveted up at the power plant since either piece would have been too large to ship completely assembled. All rivet heads were countersunk on the water side of the plates.

The suggestion for the steel liners as an improvement over the wood forms came from J. P. Jollyman, engineer of electrical construction, Pacific Gas and Electric Co., and the steelwork was designed by the engineering department of that company in accordance with the contours required of water surfaces in the draft tube by specifications of the Pelton Water Wheel Co., whose hydraulic units are used in this plant.

Construction Features of Concrete Bridge at Binghamton, N. Y

Arches Concreted in Three 20-Ft. Sections—Three-Hinged Steel Truss Arch Used for Centering —Flood Destroys Trestling

POSSIBLE flood damage and therefore necessity for keeping the channel clear led to some unusual features being incorporated in the construction of the Riverside Drive, or Memorial, bridge across the Chenango River at Binghamton, N. Y. The bridge, about completed, is being erected by the city as a memorial to soldiers and sailors of the World War. It is a five-span reinforced-concrete structure resting on piers sunk to solid rock. It has a 25-deg. skew, which was another determinant of the construction process. Spans are 86 ft. in the clear on the skew, the intrados of the arches is 13 ft. 8 in. above the springing line, the arch is 22 in. thick at the crown and the springing line is 17 ft. 4½ in. above normal water level.

Outstanding features of construction were the building of a construction trestle for the operation of both locomotive crane for handling steel and concrete and the haulage of materials to place by industrial car; and the concreting of arches between abutments in three sections—one-third of the 60-ft. width at an operation. To accommodate this style of construction the trestle was built along the bridge axis.

Because of the extent of the skew in the bridge the pile bents were spaced rather far apart—23 ft. on centers—and 24-in. I-beams were used as stringers. Pile bents were composed of seven piles: three on about 4-ft. centers forming the center row, and two more on either side of these being driven at 4 ft. 8½-in. centers to carry the I-beam for the support of ties and the crane rail. Thus the seven piles formed a sort of pier. The outside sets of piles carried 8 x 10-in. caps and the center three 12 x 12 caps. Cutoff on the outside pairs was at such an elevation that when all piles were capped they were at the same grade. Short 12 x 12's were then bolted to the capping on 4 ft. 8½-in. centers, I-beams were placed upon these and clip angles were bolted to them and to the I-beams at the joints of the latter, thus making the whole structure rigid. All pile bents were properly cross-braced.

Between the crane rails industrial track was laid and thus trestling was supplied for transporting all materials to the site and for handling it from cars to place. A 70-ton locomotive crane with lattice-steel boom was used all through the construction. A single industrial locomotive was found sufficient, after some experimen-

tation, in routing concreting materials. A switchback on both sides of the concreting plant, which was just on shore, allowed alternate pushing and pulling of loaded and empty trains. Considerable concrete work was done in freezing weather, so a heating plant was installed in the mixing shed, aggregates and water were heated and concrete left the mixer at a controlled temperature of 80 deg. F. Tarpaulins protected the green concrete until well past the initial set.

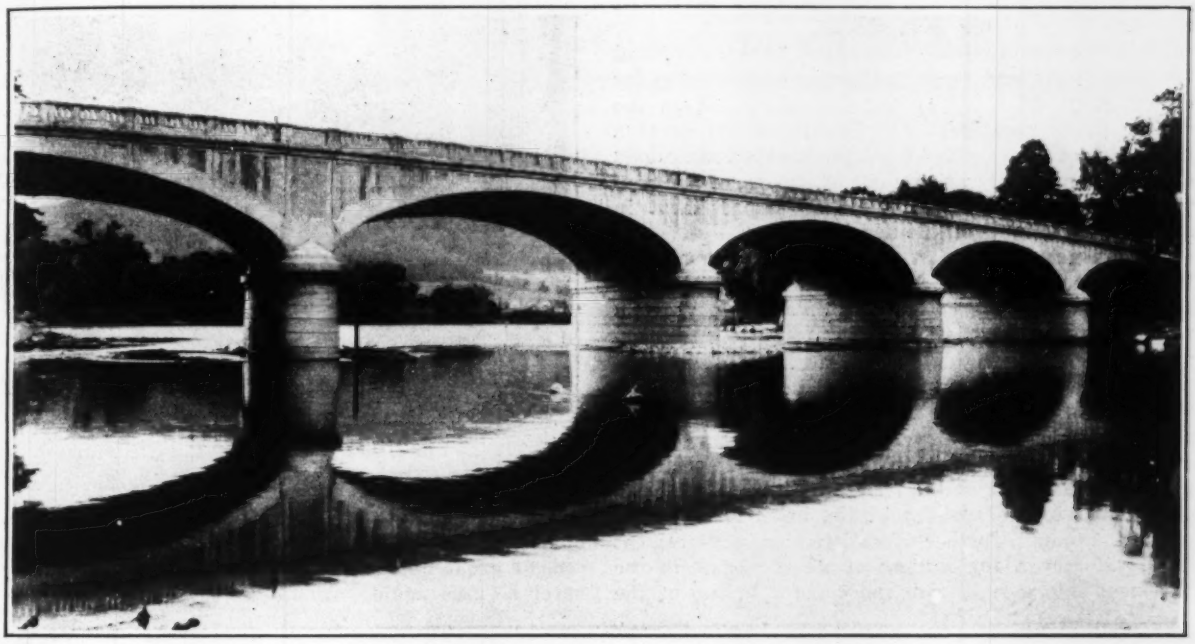
With such a plant layout the upstream third of the bridge was concreted from abutment to abutment. The downstream third was then concreted. During one of these operations a severe test had been put upon the trestle, for the water in the river rose through spring rains and thaw to 14 ft. above normal water level, and within 4 ft. of the arch crown. When the two outside thirds of the arches had been completed, another flood rose to the arch crown and took out the trestle. Revision of the construction process was then necessary as the middle third of the arch had not yet been concreted. This was done in the following manner.

The I-beams, taken from the river, were laid from crown to crown of the arches on the upstream third of the bridge. Ties and rails were laid, and then the locomotive crane pulled itself from shore onto its rails in this position, from which it not only handled concrete materials but pulled remaining timber piles. Thus there was exerted on the concrete, and only about 40 days after it had been poured, a load estimated at 100 tons (70 for the dead weight of the crane and 30 for the maximum pull upon the piles) which was concentrated at the crown of the arch.

Inasmuch as it was necessary to keep the channel clear and because of the flood danger timber centering on pile bents was not considered. In its stead the contractor had specially fabricated steel trusses. In place these formed a three-hinged arch supported on pile bents placed on the piers.

Some fast concreting was done on the structure, the best record being the pouring of five arches in six days, including time taken in moving and resetting forms. A figure of 170 yd. in a single 8-hr. day was recorded.

The bridge was built by B. L. Gabriel, engineer and contractor of Binghamton and under his direct supervision, with K. A. Moyer as field superintendent. Mr. Gabriel retained as his consulting engineer A. Burton Cohen, of New York City. The work was done with Edward H. Prentice in charge for the city of Binghamton. Contract price, including granite curbing, bitulithic wearing surface and 41 three- and single-lantern lighting units was $366,000.



MEMORIAL BRIDGE AT BINGHAMTON, N. Y.

Conflicting Water Requirements

The requirements of water for power and for irrigation along Taylor River, a tributary of Gunnison River in Colorado, are closely interrelated. Water for the Uncompahgre irrigation project is diverted from Gunnison River. Ordinarily the supply required for this use is ample, but once in 10 or 15 years there is not enough, and it has therefore been proposed to store water in Taylor Park reservoir on Taylor River to get a supply during years of low water. The adoption of this plan would, however, prevent the use of Taylor Park reservoir to store water for the generation of power. But there is some question as to the economy of maintaining a reservoir for perhaps 10 or 15 years to furnish a supply during one year in that long period. In a report prepared by E. E. Jones, a hydraulic engineer of the Geological Survey, a plan is presented by which Taylor Park reservoir could be used to equalize the flow of the river for generating power and at the same time for increasing the supply of water for irrigation late in the season so as to insure a sufficient supply except in an unusually dry year. Even without a reservoir, by constructing low dams and conduits the unregulated flow could be used to generate 17,000 hp. for 50 per cent of the time and 10,000 hp. for 90 per cent of the time. If the flow should be regulated by a reservoir at Taylor Park 33,000 hp. could be generated as a maximum and 31,000 as minimum.

Improved Asphalt Mastic Filler for Brick Pavements

Sand Heater Developed in Recent New Orleans Paving Which Assures Quick and Hot Mixture of Sand and Asphalt—Advantages of the Mastic Over Plain Filler

By Edgar J. Kelley
President, Globe Construction Co., New Orleans, La.

ASPHALT is now generally the preferred joint-filling material used in the construction of vitrified brick pavements. Its ascendency has enhanced the desirability of brick pavements for all kinds of traffic and all degrees of traffic intensity. In fact, the present general use of asphalt filler is a return to the original practice which produced so many old brick pavements that are today giving good service.

There was an interlude, from about 1900 up to about the time of the war, when preference seemed to be for cement-grout filler. Two factors contributed to the decline in its prestige: (1) Failure of too great a proportion of cement-filled brick pavements from causes directly or indirectly arising out of expansion and contraction in the brick slab, and (2) improvement in asphaltic material available for joint filler.

This is not saying that there are not many satisfactory cement-filled brick pavements, for there are. The point is, the proportion of satisfactory pavements to all that were built was too low to justify the continued use of the rigid joint filler. Longitudinal and transverse expansion cracks (worse in the North than in the South, but present everywhere), marred the appearance and in some cases impaired the serviceability of too many brick pavements. Imperfectly filled joints, which under traffic and thermal effects, contributed to the spalling of the brick in unsightly patches, brought further dissatisfaction with cement filler. Moreover, the locking of all the brick in the pavement into a rigid slab ran counter to one of the inherent advantages of the brick pavement, the salvage or re-use value of the brick themselves. Once laid with cement grout filler, for better or worse, the brick can never be used again.

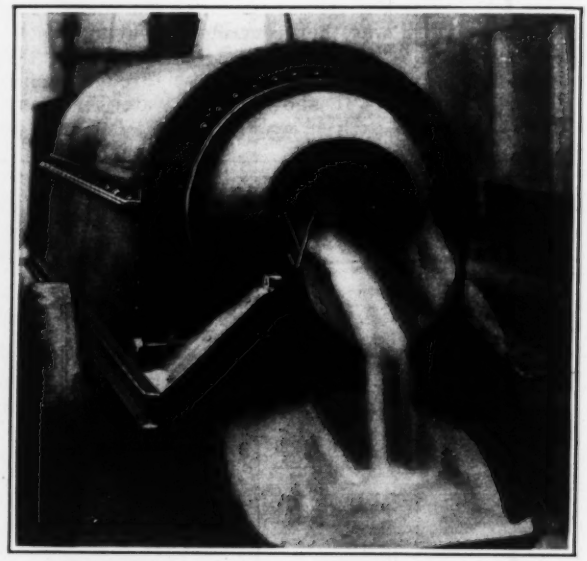


FIG. 1—DISCHARGE OF HOT FINE SAND FROM SAND HEATER

FIG. 2—PERFECT CONDITION OF BED PREPARED FOR BRICK

The first brick pavements were laid with sand, coal tar, pitch or asphalt filler. It is from among these that most of the 30-year-old pavements, in many of which the brick themselves show little signs of distress, have survived. But residual tars and asphalts in those days possessed far greater stability and toughness than they did in the later 90's and early 1900's. Methods then developed so rapidly for extracting additional marketable substances from what was formerly the residuum and the use of these residuums in pavement construction had not become sufficiently general to warrant the establishment and maintenance of high quality standards for the materials so used, that what was available for joint filler suffered in quality. The fact that cement grout filler secured what foothold it did, may be attributed, so to speak, to tar that flowed out of the joints in hot weather and got brittle in cold weather (a defect not yet remedied) and to asphalt that was so brick, not only permitted the filler to be applied at less cost than was possible by pouring, but also brought with it an improvement in the service qualities of the pavement. It made it possible to secure a brick pavement wearing surface as smooth as any type of surface that can be built, and smoother than many, and it assured likewise, the complete sealing of the pavement surface against the entrance of water.

It is not to be assumed that asphalt filler is "foolproof," for it is not. Certain precautions need to be observed. They are generally recognized by all engineers and contractors. Briefly, they are: (1) The brick must be clean, (2) the brick must be dry, and, always (3) the filler must be hot—very hot. Given clean, dry brick, and asphalt filler heated to at least 350 deg. F., and hotter if possible, up to 400 deg. F., there is no reason why perfect penetration of filler in the finest of joints will not be secured, and in many cases

FIG. 3—MASTIC REACHES PAVEMENT PIPING HOT

lacking in adhesiveness and "life" that it chipped out of the joints like so much charcoal.

The movement for a higher quality of asphalt filler for brick pavement began about 1910 in the West. This activity had attained strength by 1915, and was spreading eastward. The general sentiment in favor of asphalt filler was undoubtedly crystallized about 1919, when special attention was paid to specifications for asphalt filler for brick pavement by the Standard Oil Co., The National Paving Brick Manufacturers Association, The Texas Co. and other large producers of asphaltic cement. Engineers were quick to recognize the improvement in asphalt filler available for use. There are now few of them who specify cement-grout filler.

Improvements in Methods of Application—Hand in hand with improvement in the asphaltic cement itself came the method of applying the joint filler in quantity on the surface of the pavement and squeegeeing it into the joints while still piping hot, contrasted with the former tedious method of pouring. This method of application, which has come to be an accepted way of applying the filler in connection with vertical fiber it is observed that the filler even curls under the bottom edges of the brick and penetrates between brick and bedding. Followed, then, by the ironing effect of traffic, aided by warm weather, a perfectly smooth surface is made and a thin coating of asphalt remains on the granular surface of the brick often for many years.

For some years, the writer has been interested in experiences with asphalt-mastic filler. Considering the fact that it is customary to spread sharp sand over the surface of the pavement immediately after squeegeeing the asphalt filler into the joints, in order to toughen the surface coat, the application of such sand must be regarded as an advantage. If it is an advantage so applied, the conclusion naturally follows that it would be of greater advantage if the sand were intimately incorporated into the filler. In other words, would not an asphalt-mastic filler be better than a plain asphalt filler?

Naturally, this line of thought is not original with the writer. Other engineers and contractors have given much consideration to the subject; many of them, including himself, have tried mastic filler from time to

time, if not with brick pavement at least with granite block pavement. It is safe to say that the reason why mastic filler, in spite of its theoretical advantages over plain asphalt filler, has not developed farther, was due to lack of suitable means of heating sand hot enough, and fast enough, to provide thorough mixing with the hot asphalt in sufficient quantity to maintain the required rapid pace of filling the joints. As a result of reflection over the matter, the writer participated in the development of a sand-heater which experience has shown has overcome the disadvantages which formerly attended the mixing of mastic-filler and which, in the writer's judgment, produces a brick pavement filler superior in every way to plain asphalt filler.

The machine is a muffled type of heater with a horizontal shaft, running through the center, equipped with inclined blades which at once keep the sand in the drier turning over and over and move it from the entrance to the discharge. Given fine-grained sand, it travels readily through the heater and is discharged as shown in Fig. 1 in a stream. The temperature of the sand is close to 350 deg. F. Sand holds its heat well. It is immediately transferred to an open barrow, in measured quantities of two parts of sand to one of hot asphalt, and thoroughly mixed with hoes, or into an open box equipped with paddles for agitating the contents until thoroughly combined, whence, from either, the mastic is discharged upon the surface of the pavement, and at once squeegeed into the joints. The entire operation of combining the hot sand and asphalt does not require more than two or three minutes. The loss of heat is negligible. Fig. 3 gives an idea of the temperature of the mastic when applied by the smoke arising from the barrow and from the pavement.

If the sand is fine-grained, and there are few localities where such sand cannot be had, the penetration of the mastic into the finest joints is immediate and complete. The filler in the joints and the thin coating on the surface of the brick seems to have a toughness and substantial character superior to plain asphalt filler. It irons out under traffic and provides a smooth, tough and substantial thin carpet over the surface of the pavement that is unusually enduring. In addition to the improvement in the physical properties of the filler there is also an economy in cost, even after the investment in the heater is included in the reckoning. Such asphalt mastic filler has all the desirable properties of asphalt fillers generally plus the further advantage of improvement in durability and economy of cost.

The Globe Construction Co. has used this machine in the filling of granite block pavement in considerable amounts in New Orleans. It has completed the filling of some 17,000 sq.yd. of vitrified brick pavement on Claiborne St. in New Orleans and is now engaged in the construction of approximately 23,000 sq.yd. of brick pavement on Washington Ave.

This work is under the general direction of John Klorer, formerly city engineer and now commissioner of public property, and under the immediate supervision of Louis A. Buja, assistant engineer.

Whole Town Moves to Make Way for Reservoir

Raising the level of Lake Kenogami, Quebec, by the construction of higher dams at its outlets necessitates the expropriation of the entire village of St. Cyriac, whose residents have been given land in another district and will move en masse.

Tests on Composite Tile Block and Concrete Sewer

Repeated Loads Applied by Means of Specially Constructed Hydraulic Jacks Show Strength of Unusual Type

By Raymond E. Davis
Associate Professor of Civil Engineering, in Charge of Material Testing, University of California, Berkeley, Calif.

RECENTLY the writer completed a series of loading tests on a composite clay tile and concrete sewer, which tests were rather unique both by reason of the manner in which loads were applied and on account of the character and scope of the data obtained.

The test section, the details of which are shown in Fig. 1, was composed of a cylindrical barrel of vitrified blocks laid in cement mortar, the upper half of the barrel being reinforced with curved reinforced-concrete beams. The inside diameter of the section was 60 in., and the length was 8 ft. 6 in. As indicated in the figure, the barrel was made up of solid inner blocks or

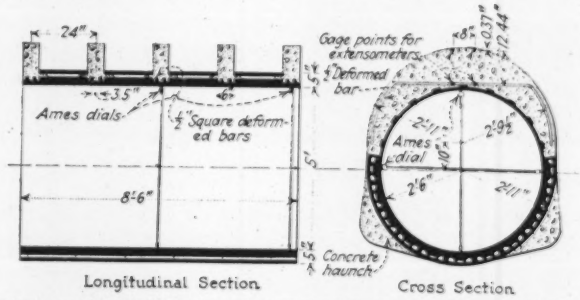


FIG. 1—COMPOSITE TILE AND CONCRETE SEWER TESTED

liners and hollow outer blocks in which the openings ran lengthwise of the pipe. For the upper half of the pipe, the outer blocks were laid in rings 18 in. wide. The curved beams occupying the space between adjacent rings of exterior blocks were 6 in. wide and varied in depth from 14 in. at the crown to 4 in. at the spring line. Each beam was reinforced with two ½-in. square deformed bars bent as shown. Below the horizontal diameter the pipe was bedded in the natural earth, a fine-grained black adobe, containing 26 to 28 per cent of moisture.

To secure uniformity of bearing pressure and facilitate the tests, loads were applied by means of four hydraulic jacks of special design, reacting against an overhead platform loaded with pig iron. Pressures were transmitted through a sand bearing extending over an arc of 90 deg. as measured on the exterior surface of the barrel of the pipe. Fig. 2 shows the manner in which the jacks were mounted in position.

During the progress of the test, observations were made to determine: (1) The change in vertical diameter at center and end, termed the *vertical deflection;* (2) the change in horizontal diameter at center and end, termed the *lateral deflection;* (3) the elongation in the reinforcement steel at the crown of the curved beams; (4) the compression in the concrete at the crown of the curved beams; (5) the compressibility of the soil in which the pipe was bedded.

Tests made on 6x12-in. concrete cylinders showed the concrete of the curved beams to have an average compressive strength of 2,025 lb. per sq.in. at 28 days and 2,355 lb. per sq.in. at 39 days.

The tests made may be divided into three parts:

1. *Tests Under Working Loads*—The purpose of these tests was to determine the behavior of the test section under working loads both sustained and applied intermittently. Over a period of 15 days, beginning when the section was 23 days old, various loads up to 61,500

FIG. 2—SEWER SECTION IN TESTING MACHINE

lb. (1,450 lb. per sq.ft.) were applied and maintained for various periods up to three days, and were then released. At the end of the period under the 61,500-lb. load, the deflections were 0.035 in. vertically and 0.042 in. horizontally, and the stresses at the crown of the curved beam as calculated from observed deformations were for the steel 3,800 lb. per sq.in. and for the concrete at the extreme fiber 350 lb. per sq.in. No cracks were visible either in the curved beams or in the segment block barrel. Upon the release of the above load the permanent deflections were 0.014 in. vertically and 0.015 in. horizontally, and due to permanent deformations in the section there was a residual stress of about 1,700 lb. per sq.in. in the steel at the crown of the beams. Throughout the test, end and center deflections for a given load were practically the same.

2. *Test to First Crack*— This was a rapid loading test occupying about 1½ hours. It was performed 39 days after the completion of construction of the test section. Gradually increasing loads up to 123,000 lb. (2,900 lb. per sq.ft.) were applied for short intervals and then released. At the above load the first hair crack in the joint between liners at the crown was observed to extend for the full length of the pipe. No other cracks were observed, and when the load was released, the crack appeared to close perfectly.

In Fig. 4 the diagrams marked "No. 2" show the vertical and lateral deflections under various loads. Similarly in Fig. 5 the curves marked "No. 2" indicate the stresses at the crown of the curved beams in the reinforcement steel and in the extreme fiber of the concrete. Under the 123,000-lb. load the deflections were 0.111 in. vertically and 0.136 in. horizontally, and the stresses at the crown of the curved beams were about 13,500 lb. per sq.in. in the steel and about 1,000 lb. per sq.in. in the extreme fiber of the concrete. When the 123,000-lb. load was released the residual deflections were 0.053 in. vertically and 0.066 in. horizontally, and there remained a residual tension of about 5,000 lb. per sq.in. in the steel at the crown of the curved beams. It will be observed that at about 100,000 lb. there was a marked change in the direction of the diagram, indicating a sudden redistribution of stress.

3. *Test to Failure*—These tests, occupying about 1½ hours, were made when the section was 46 days old. Loads were progressively increased until failure occurred. In general after each application the load was released. In Fig. 4 the curves marked "No. 3" indicate the vertical and lateral deflections, and in Fig. 5 the diagrams marked "No. 3" give approximate stresses in steel and concrete based on extensometer measurements.

At a load of 96,500 lb. the longitudinal cracks noted during the preceding test again became visible. At a load of 131,500 lb. longitudinal cracks appeared in the joints between liners on either side of the crown, between liners along the center line at the bottom, and between exterior blocks just above the horizontal diameter. Also in the beams, cracks just below the plane of the reinforcement were observed to extend outward on either side of the crown.

Under the ultimate load of 173,000 lb. the section continued to deflect and the cracks in the beams opened up and extended rapidly.

It is instructive to note the material increases in deflections and stresses of the last test as compared with those for corresponding loads of the test preceding the first crack, an indication of the decreased resistance of the segment block barrel to bending stresses. It seems entirely probable that the earlier tests had opened up

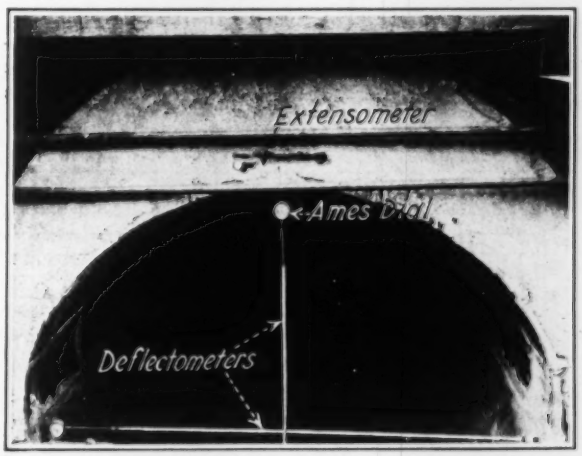


FIG. 3—CLOSE-UP SHOWING DEFLECTOMERS

microscopic, longitudinal cracks between segments so that during the final test the bending stresses were very largely carried by the beams.

Fig. 6 illustrates the almost identical manner in which the several beams failed. On the end beam may be noted the manner in which initial failure was caused by the cracks numbered 1 and 2. In general, final failure was accompanied by slipping of the bars near the spring line and by cracks in the plane of the reinforcement extending from the crown to the spring line.

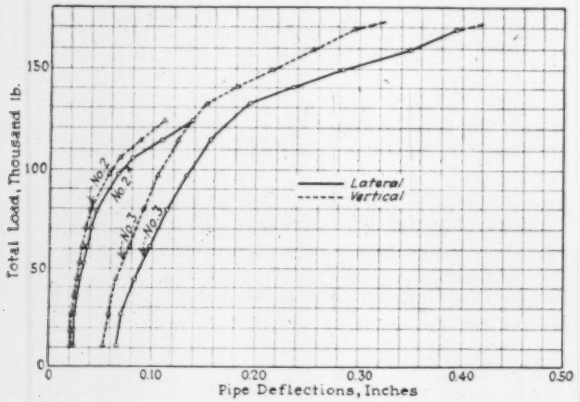


FIG. 4—PIPE DEFLECTIONS UNDER HEAD

Comments—Reviewing the results of the tests, it would appear that in practice the design might be expected to withstand a load of 2,000 lb. per sq.ft. of horizontal projection without visible cracks appearing in the lining, even under conditions less favorable than those surrounding the experiments here described. In view of the relatively low bending stresses in the steel and in the extreme fiber of the concrete at the crown it would seem that the effective depth of the curved beams at the crown might be materially reduced, and still provide a structure adequate in strength for almost any location. The type of failure suggests that the reinforcement while adequate in cross-sectional area is not effectively placed to develop the maximum strength of which the beams are capable. Obviously a better arrangement would be to provide two bars reinforcing the lower or inner elements of the beam on either side of the crown to perhaps the quarter points, and to reinforce the upper or outer elements by a single bar on either side adequately anchored to the concrete invert and extending upward to perhaps the third point.

The design is such that there is practically no negative moment carried by the section in the region of the spring line, particularly after loading has proceeded to

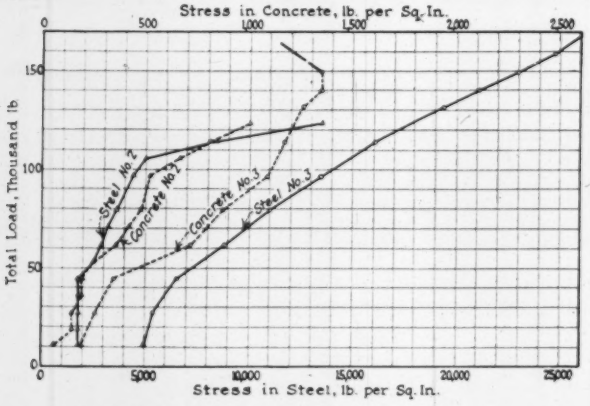


FIG. 5—STEEL STRESS UNDER LOAD

the point where longitudinal tension cracks have opened up at the joints between segment blocks; and thus the curved beams may be considered as simply supported at the spring line. As load is applied and deflection takes place laterally, the beam reactions become inclined inward, or, in other words, at each end of the beam there is a horizontal thrust. Clearly the magnitude of this thrust, which is dependent upon a number of factors besides the load, cannot be determined by theoretical analysis, but will vary as some function of the rigidity of the earth mass supporting the section below the spring line.

A study of the data indicates that, for conditions similar to those surrounding the test, maximum positive moment may be approximately determined by

FIG. 6—SPECIMEN AFTER TEST

assuming the horiontal component of the beam reaction as being one-quarter the vertical component. With reinforcement placed as previously suggested, calculations indicate that working stresses in steel and concrete would not be exceeded if the effective depth at the crown were made 12 in. for a load of 2,000 lb. per sq.ft. of horizontal projection, or 10 in. for a load of 1,500 lb. per sq.ft. of horizontal projection.

State and Local Co-operation in Reclamation

"The potential beneficiaries of reclamation development are the reclamation district, the state, and the nation. Ordinarily their immediate material interests would seem to be in the order named. With such community of interest, should not some rational basis of co-operative effort be evolved? If the various states have the courage and confidence of the reclamation possibilities within their respective borders, then they should be willing to co-operate and share responsibility and control with the federal government in the development of those possibilities. It may be that with such co-operation there would result a more rapid and effective development and a more wholesome and satisfactory development than is possible without it. Federal aid of road construction is an illustration of successful co-operation. The Smith-McNary Bill introduced in Congress a few years ago but not enacted into law was an effort in that direction and, moreover, it provided for a very substantial revolving fund to commence operations. Any new co-operative legislation that may be proposed should be sufficiently flexible to permit such variation in the division of financial and technical responsibility as the conditions peculiar to the particular project in hand may indicate as necessary or advisable."—Joseph Jacobs, in presidential address to Washington Irrigation Institute.

Engineers Discuss Earthquake Experiences and Cautions

Santa Barbara and San Francisco Effects—Steel vs. Concrete—Present Methods Do Not Attain Safety

DUE to the very general interest of the local engineers in the damage done to buildings by the Santa Barbara earthquake of June 29, 1925, the San Francisco Section of the American Society of Civil Engineers held a special meeting to discuss the general subject of the proper types and methods of buildings to resist earthquakes, as illustrated by the behavior of buildings in Santa Barbara. Approximately 400 members and guests were in attendance, whereas the regular meetings seldom draw an attendance of 150.

The speakers for the evening were J. D. Galloway, L. H. Nishkian and H. J. Brunnier, consulting engineers. The discussion following the three principal addresses was participated in by Dr. Bailey Willis, president of the Seismological Society of America; W. H. Kirkbride, engineer of maintenance of way, Southern Pacific Co., H. D. Dewell and J. B. Leonard, consulting engineers.

The high points of Mr. Galloway's remarks were (1) that the buildings which failed either in whole or part gave a better idea of the effect of an earthquake on building construction than did those structures which showed no damage; (2) that the general failure of buildings with brick bearing walls and timber interiors bore a striking resemblance to the failures of buildings of this type in the 1906 California earthquake; (3) that, in the case of the failure of the Californian Hotel, his opinion was that had the floor joists been properly anchored to the brick wall, the structure would have collapsed, the walls pulling the floors out; (4) that a building of this general type can not be expected to withstand an earthquake shock; (5) that brick walls will continue to be used, despite their unsuitability to resist the tensile stresses induced by an earthquake, the factor of unsurpassed resistance to fire being so important; (6) that, fundamentally, a steel building frame is superior to a reinforced-concrete frame, due to the constant moment of inertia of steel floor girders per unit of span, and the substantially equal resistance of steel columns to compression and shear, as contrasted with the varying moment of inertia of reinforced-concrete girders and the weakness of the ordinary reinforced-concrete column to shear and diagonal tension; and, (7) that hollow tile is inherently an unsuitable material for walls of buildings likely to be subjected to earthquake.

Mr. Nishkian dealt almost wholly with the question of design. He agreed with Mr. Galloway in considering reinforced-concrete curtain walls superior to brick walls, and also in being opposed to terra cotta walls. He took issue with Mr. Galloway on the subject of the unsuitability for earthquake shocks of a reinforced-concrete frame designed for vertical loads as compared to a structural frame. Mr. Nishkian exhibited charts showing the resultant of combined stresses in beams and columns of a building due to vertical and lateral forces, and pointed out that when correctly designed for vertical loads, a reinforced-concrete floorbeam has its maximum resistance at its junction with the column, at which point the bending due to lateral forces on the building is also a maximum. Due to the monolithic character of reinforced concrete, and the consequent rigidity of column and beam connection, he considers the average reinforced-concrete frame superior to the average steel frame, in which the connections of beam to columns have practically no resistance to bending. However, a building with steel frame designed to resist the proper lateral forces and with reinforced-concrete walls represents the highest standard of building construction from all viewpoints, and is superior to a reinforced-concrete frame. In this connection he suggested that the lower-story curtain walls of reinforced concrete should be made much heavier than present practice in San Francisco (6 in. reinforced concrete) and also favored, as a possibility, the use of thinner walls in the upper stories.

Pointing out that there are two methods of constructing buildings to resist earthquakes, viz., (1) designing a frame sufficiently strong to resist the stresses, and (2) making use of a "limited-slip hinged joint" under the second floor and above the first floor, so that the upper part of the building might remain approximately fixed while the earth moved beneath it, Mr. Nishkian exhibited a proposed detail of such joint. His other comments included:

(1) that the provision of the local building law allowing masonry bearing walls for a height of six stories should be repealed; (2) and that the repair of damaged reinforced-concrete buildings is not as serious a matter as some consider it. He recited his own experience in repairing a two-story-and-basement reinforced-concrete garage whose columns had settled and whose floors and girders had cracked on account of poor design. He successfully repaired it by jacking up the columns, cutting out the damaged portions, forcing the foundation piers through applied pressure to a condition of security against further settlement, welding splices into the column bars, reconcreting, cutting out all damaged concrete in floors and girders, putting in additional steel, and reconcreting. The same methods could be applied to such buildings in Santa Barbara as the St. Francis Hospital, at relatively low cost, putting the buildings in as good shape as they originally were.

Mr. Brunnier, in his remarks, paid particular attention to the quality of construction found in Santa Barbara, particularly with reference to brick masonry. He cited instance after instance of his observation of poor quality of mortar, poor brick, lack of bond, absence of headers in brick masonry, and lack of proper bonding of end and side wall. Referring to the failure of tile walls, he spoke of the use of partition tile in curtain walls. In his opinion, much of the failure of tile walls could be laid to the use of an improper type of tile in walls. In this connection he pointed out instances of the satisfactory service of tile in some of the buildings, both with and without structural frames. With respect to buildings with brick bearing walls, Mr. Brunnier would limit their height to three stories. He urged that the lesson of the prevalence of poor materials and construction in Santa Barbara be not forgotten, and that engineers unite to stand firmly for a better class of construction, and to refuse to design the structures of buildings for architects or owners who refuse to give proper attention to quality of materials and workmanship.

All three speakers condemned in no uncertain terms the obviously poor design of such buildings as the San Marcos, the St. Francis Hospital and the Lincoln School,

pointing out that these buildings were unquestionably skimped in their provision for the ordinary vertical loads.

Dr. Willis spoke of the earthquake from the standpoint of seismology. Comparing the Santa Barbara shock with that of 1906 in San Francisco, he stated that from the viewpoint of the seismologist, on the basis of the extent of damage, area affected, energy expended, the Santa Barbara earthquake was of small dimensions. Comparing intensities of shock, there were certain cases in Santa Barbara where the intensity approached that of the 1906 shock. Dr. Willis stated that a second fault was now recognized, approximately parallel to and near the Southern Pacific tracks, as far west as Naples. In the 1906 earthquake there were displacements along the fault line as great as 20 ft.; in case of Santa Barbara, there were no appreciable displacements along the fault lines.

Mr. Leonard cited his experiences with reinforced-concrete bridge construction in Humboldt County, California, during an earthquake some years ago. Some damage to the bridge had been done, but repairs had been easily made. Mr. Leonard also gave figures on a comparative design of a steel column of H-section and one of reinforced concrete, each designed for the same load. Compression, bending and shear were considered. In the case considered, due to the shape of the H-section he found that the concrete column was superior in bending, when lateral forces in all directions were considered.

Mr. Kirkbride described the effects of the earthquake on his railroad. These effects were largely those of subsidence, although some water tanks on timber posts were thrown down. The Santa Barbara station, a building with heavy brick walls, though damaged, has been used continuously, and, in Mr. Kirkbride's opinion, is structurally safe.

Mr. Dewell brought out some of the underlying facts of the effect of earthquakes on buildings. He pointed out that every building has a natural elastic vibration period of its own. The average period of a destructive earthquake is approximately one second. Those buildings with a natural period of vibration of less than one second are known as "short blocks or columns." Those with a period of vibration materially in excess of one second are known as "long columns." The buildings of Santa Barbara were of the first class, i.e. short columns. On these the areas of great damage are in the lower stories. In the buildings of the second type, in which fall the higher office buildings, there is an effect akin to that of the "center of percussion." This point is approximately two-thirds of the height of a building or similar structure, as a chimney. In such structures, heavy damage is probable in the area adjacent to the center of percussion. Proper design for resistance of earthquake must consider the structure from the standpoint of shape and distribution of mass. If thin walls are to be used in the upper stories of buildings, this point must be considered.

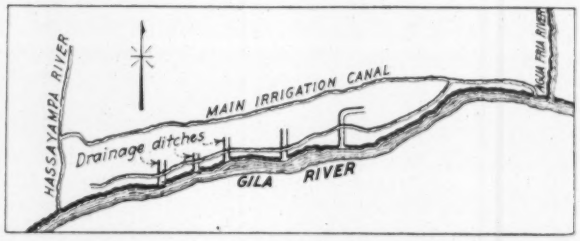
Mr. Dewell urged that the San Francisco Section exert itself to bring about more general appreciation of the earthquake hazard and the need for protecting against it by proper design. He stated that as poor construction as was evident in Santa Barbara exists in San Francisco, and there is need for more strict supervision of building construction. He recited the fact that the building ordinance of San Francisco drafted immediately after the catastrophe of 1906 prescribed the use of a wind pressure of 30 lb. per sq.ft. This provision was based on the conclusion of the Special Committee of the American Society of Civil Engineers that a building consistently designed for this wind pressure would satisfactorily resist an earthquake of the intensity of 1906. Today the prescribed wind pressure is 15 lb., a reduction of 50 per cent. The live-load for office buildings has been reduced nearly 50 per cent, and the unit stresses for steel increased. Buildings now erected in accordance with the building law are far lighter than those that safely withstood the 1906 shock. San Francisco is *not* building for safety against earthquakes, and the same statement applies to the East Bay cities.

Drainage Reclaims Waterlogged Land on Old Project

Shoestring Project Reduces Ground Water Level by Simple Drainage Ditches Crossing Under Irrigation Ditches

By H. L. Hancock
Consulting Engineer, Phoenix, Ariz.

In the lower central part of Arizona, in the Buckeye Valley is an irrigation district which demonstrates anew the old principle in the reclamation of land, namely, that the maintenance of the ground-water level



BUCKEYE VALLEY IRRIGATION DISTRICT, MARICOPA COUNTY, ARIZONA

at the proper height relative to the surface is fully as important as the delivery of adequate supplies of water.

The Buckeye Valley is situated on the north side of the Gila and the Agua Fria Rivers and stretches in a westerly direction to the Hassayampa River, being 22 miles in length and averaging under 2 miles in width, with a total area of 22,000 acres. With rich soil, an average growing season of 289 days and an average yearly temperature of 69.4 deg. F., the valley is in every respect, except one, an ideal section for farming operations. The one deficiency is its lack of rainfall of which it has only an average of 8.04 in. for the year.

In 1885 a canal was built for the irrigation of this fertile valley. In 1906 the original canal company was taken over by the Buckeye Irrigation Co., organized as a co-operative enterprise by the farmers of the district. The company operates without profit, water being supplied to its members at cost, which has averaged about $2.75 an acre per year, including assessments for improvements and extensions. Of the 22,000 acres in the district 17,000 are now supplied with irrigation service. The system as originally laid out and as since enlarged, consists of a main canal diverting

water from the Gila River at a point just below the junction of this river with the Agua Fria River. The canal, which is 24 miles in length, runs in a southwesterly direction, terminating in the Hassayampa River, and is the northern boundary of the district. At its head the canal is 20 ft. wide and carries 5 ft. of water. It has a fall of 0.04 ft. per 100 ft. and an average flow of 14,000 miners inches. Lateral branches divert the water from the main canal at intervals of about one-half mile. These main laterals have a capacity of from 300 to 200 miners inches. Secondary laterals supply water to the individual fields.

While Buckeye Valley has been irrigated for thirty-nine years it is only within recent years, when the area under cultivation had grown to its present extent, that attention has been directed to an incorrectly placed ground-water level. It was observed that a considerable portion of the irrigated land, some 3,000 acres in extent, could not be cultivated because the soil was waterlogged. On about 1,000 acres water stood at the surface and even small lakes had formed. The solution for this condition clearly was some form of drainage by which the excess water could be removed and the ground-water level lowered. An open-ditch drainage was selected as the method most suitable. Five ditches with a total length of 7 miles were built in 1923 by the Jennings Construction and Engineering Co. under the direction of the writer.

The drainage and irrigation systems crossed each other at a number of places. In four cases the irrigation canal was carried over the drainage ditch in steel

EXCAVATOR STRADDLES COMPLETED DITCH WORKING UPSTREAM

Long before it was completed the drainage ditch carried away a surprisingly large volume of seepage water.

flumes, supported by a concrete abutment wall at each end. Undermining was prevented by a concrete lining in the canal at each end of the flume, such lining being 20 ft. in length.

At some crossings there was a public road alongside the canal. Here the drainage ditch was carried under both roadway and canal in 72-in. corrugated culverts with concrete head and wing walls.

The results obtained with this drainage system were immediate and astonishing. Even before the first ditch had been completed a surprisingly large amount of water was being removed, and when completed the ditch carried a flow sufficient to cover 900 acres of land

IRRIGATION CANAL CARRIED OVER DRAINAGE DITCH

Steel flume supported by concrete abutment walls with concrete lining extending a short distance each way to prevent undermining.

12 in. deep every thirty days. For miles around the ground-water level was lowered several feet almost immediately, and areas that formerly had been a waterlogged bog became firm and solid land which in the hands of the skilled farmer will again become fine agricultural land.

It is now realized that in Buckeye Valley there need not be any unproductive land. With an ample supply of water available it is only a question of so adjusting the ground-water level by means of drainage that all land can be cultivated. Nor need the water removed by drainage be wasted. Plans are now being formulated for using this water to irrigate fields not previously served and in that manner further increase the total area of productive land. When this has been done all the water diverted from the Gila River will be used to full advantage without waste, and the area served will have been made 100 per cent productive.

London Plans $20,000,000 Port Development

The Port of London, continuing an elaborate plan for the development of its shipping facilities, is now preparing to spend an additional $20,000,000 on harbor work. The chief items will be: (1) Building a large floating landing stage for passengers at Tilbury adjoining the London, Midland & Scottish Ry. station. There will be a depth of water alongside the stage of 35 ft. below low water at ordinary spring tide in order to allow the largest liners to come up to the stage. Bridges will connect this landing stage with the shore. (2) The construction of a 1,000-ft. entrance lock and a 1,000-ft. dry dock near the landing stage. (3) Bringing the West India docks up to greater efficiency by constructing a new entrance to allow all ships up to 12,000 tons to come into the dock, and the linking up of the three West India dock basins. The plans for this work are now ready and it is hoped to have it under way in the near future so that it can be finished in about four year's time.

From Job and Office

Hints That Cut Cost and Time For the Contractor and the Engineer

Comparison of the Parabola and Arc of Circle for Pavement Crowns

By Edward E. Bauer
Instructor in Civil Engineering, University of Illinois, Urbana, Ill.

BOTH the parabola and the arc of a circle are designated by engineers to determine the exact shape of the surface of a pavement. For the range of crowns and widths in current practice there is for all practical purposes no difference between the results secured by the two methods.

The crown is defined as the vertical distance between the surface at the middle and at the edge. This is indicated by the distance *BC* in the accompanying figure.

Parabola. Distances from the line *AB* to the surface of the pavement, *AEC*, vary as the square of the distance from the point *A* to the point where the vertical distances are measured. At the point *D*, which is half way between *A* and *B*, the offset *DE* is one-fourth the distance *BC*. This is a very simple method of determining the points along the surface of the pavement.

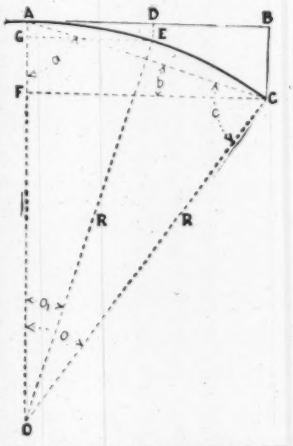


FIGURE SHOWING TYPES OF PAVEMENT CROWN

Arc of a Circle. In using the arc of circle it is necessary to find the radius, *R*. The conditions are that the circle shall be tangent to the line *AB* at *A*, and shall pass through the point *C*. By trigonometry angle *a* equals angle *c*.

$$\text{Angle } o = 180° - a - c$$

but $a = 90° - b$, therefore angle $o = 180° - 2(90° - b)$ or, angle $o = 2b$;

$$\tan b = \frac{AF}{FC} = \frac{BC}{AB}$$

$$\sin o = \frac{FC}{OC} = \frac{AB}{R}$$

To find the offset *DE*: *AD* and *EO* (which is the radius) are known, and from which o_1 can be determined. Then

$$R \text{ vers } o_1 = AG = DE$$

Offsets at other points between *A* and *B* may be found in the same way.

In the accompanying table are given the results of the two methods for some common widths of pavement and crowns.

From this table it is noted that as the pavement becomes narrower the radius decreases. The greatest difference between the arc of a circle and the parabola is 0.05 of an inch, which is less than one-sixteenth of an inch. Since it is impossible to build a pavement surface that does not vary more than a sixteenth of an inch from the theoretically true surface, there is no need to designate any other surface than the parabolic form.

Dist. *AB* Feet	Crown *BC* Inches	Radius, Feet	Offsets from Line *AB*—Inches					
			¼ *AB*		½ *AB*		¾ *AB*	
			Arc	Parabola	Arc	Parabola	Arc	Parabola
25	6	625.14	0.3750	0.3750	1.500	1.500	3.385	3.375
20	5	480.37	0.3006	0.3125	1.243	1.250	2.784	2.81
15	4	337.68	0.2472	0.2500	0.9867	1.000	2.202	2.252
10	2.25	266.77	0.1351	0.1406	0.5602	0.5625	1.265	1.

Checking Tank Car Quantities in Road Work

By Harry J. Kirk
Chief Engineer of Maintenance, Department of Highways, Columbus, Ohio

THERE is only one practical way to check the quantity of bituminous materials shipped in tank cars—measure the quantity in the car on arrival and then see to it that the entire contents are delivered on the road job. One calculation on the tank car then takes the place of measuring many distributor loads. Two measurements are necessary in making the calculation, first the "outage" of the tank car in inches, second, the temperature of the material in the tank car.

Outage is the distance from the inside of the car shell at its highest point vertically to the surface of the liquid in the car. When the car is empty the outage is the distance from the inside of the top of the shell to the inside of the bottom of the shell which is practically the inside diameter of the tank measured vertically. When the car is so full that the liquid is in the dome, there should be measured the distance the level of the liquid is above the top of the tank car shell, together with the inside diameter of the dome.

A simple method of measuring outage is as follows: Obtain a measuring stick about 1 in. x 5 ft. graduated in inches with a metal strip fastened on one end as in a T-square with but one arm to the T (Fig. 1). Lower the stick to the surface of the liquid and read inches at top of car dome. Raise the stick until the metal strip meets the top of the tank car shell and again read inches at the top of the dome. The difference is the outage. When the material completely fills the car shell and partly fills the dome, the depth and diameter of the dome must be taken in order to compute the gallons in the dome.

As bituminous materials are ordinarily shipped, the temperature of the liquid can be taken as the mean air temperature for the past 24 hours. It is accurate enough for practical purposes to consult some convenient thermometer and unnecessary to insert it in the liquid. Where bituminous materials are shipped in jacketed cars at high temperatures a thermometer will have to be inserted in the car. All contracts which

specify the quantity of bituminous materials in gallons should also specify the temperature at which the gallons are to be calculated. Between 60 and 300 deg. F. tars and asphalts will expand 7.92 per cent in volume.

The capacity of the tank car shell must be known. This is sometimes found stenciled on the end of the car (Fig. 2). If it is not found there it may be obtained from a circular of United States and Canadian railroads showing tank car capacities, issued by E. B. Boyd, Agent, Chicago, Ill., which gives the shell and dome capacity of all tank cars in service. An outage table is also necessary in solving this problem. Such a table gives the quantity of material in gallons out of the car for each inch of outage. Complete tables may be obtained from manufacturers who ship materials in tank cars.

Two practical problems in checking tank car quantities will explain the process completely:

Car—U.T.L.X. No. 6902 is filled with penetration asphalt which material is measured at 300 deg. F. according to Ohio Highway Department specifications. The outage is 3 in., distance from surface of asphalt to top inside of car shell. The temperature 200 deg. F. at time of pumping first load. From the outage

FIG. 1—MEASURING TANK-CAR OUTAGE WITH L-RULE

table 3 in. outage is equivalent to 98 gal. The circular of tank car capacities gives U.T.L.X. No. 6902, a capacity of shell of 8,074 gal. The computation is then:

$$V_2 = V_1[1 + B(t_2 - t_1)]$$

where V_1 = volume of a substance at a temperature t_1, V_2 = volume of a substance at a temperature t_2, and B is a constant and may be taken as 0.00033 for either tars or asphalts.

$$V_2 = (8{,}074 - 98)\ [1 + 0.00033\ (300 - 200)\ ] =$$
$$7{,}976 \times 1.033 = 8{,}239 \text{ gal. at 300 deg. F.}$$

Where the material partly fills the tank car dome the procedure is as follows: Car B.M.X. No. 308 is filled with penetration tar which is measured at 200 deg. F. according to Ohio Highway Department specificatifions. The depth of the dome equals 24 in. The diameter of the dome equals 42 in. and the distance from the surface of tar to top of dome equals 20 in. The temperature of the air assumed as the temperature of the tar is 80 deg. F. From the circular of tank car capacities the shell capacity of B.M.X. No. 308 is found to be 10,200 gal. and the dome capacity 145 gal. Now 24 in. in the dome is equivalent to 145 gal. or 1 in. in the dome is equivalent to 6 gal.; 24 in. — 20 in. = 4 in., which is equivalent to 24 gal.

Then 10,200 + 24 = 10,224 gal. at a temperature

FIG. 2—SHOWING CAPACITY STENCILING ON TANK CAR

of 80 deg. F. To correct to 200 deg. F.,

$$V_2 = 10{,}224\ [1 + 0.00033\ (200 - 80)\ ] =$$
$$10{,}629 \text{ gal. at 200 deg. F.}$$

It will be observed that the correction for change in temperature is the addition or subtraction from the original volume, according as the basic temperature is lower or higher, of a figure, representing the product of the original volume by the change in temperature by 0.00033, the co-efficient of cubical expansion.

If the above check is made on all tank car deliveries of bituminous materials there will be many surprises in store both for the engineer and the contractor.

"Rust-Jointing" Delaware River Bridge Approach Column Bases

By Percival M. Sax, Jr.
Field Engineer, American Bridge Co., Philadelphia, Pa.

To transfer the load from the column bases to the cut stone piers of the Delaware River (Philadelphia-Camden) bridge approaches, the method known as "rust-jointing" was deemed preferable to the use of lead plates or cement grout. The material consisted of two hundred parts by weight of iron borings, two of sal ammoniac, and one of flowers of sulphur. To this was added just enough water to thoroughly moisten the mass without having any forced to the surface by the ramming tools—the amount naturally varied with the moisture in the air. As this material not only stains any stonework with which it is in contact for any length of time, but also tends to react and to give off strong ammonia fumes within a half hour after mixing, it was necessary to devise means for ramming it into place rapidly while keeping it out of contact with the piers.

The column bases were set temporarily upon shims, giving joints which varied from ¾ to 1¼ in. Where there were many piers of the same size galvanized iron shields were used to protect the stonework, while in irregular places sheets of roofing paper were used instead. When the shields were in place the material

was mixed, and at once rammed under the casting by means of L-shaped bars, care being taken to compact the mass thoroughly. The edges were then calked with lead wool, after which the shields were removed and the stonework carefully brushed to remove any remaining particles of the iron. It was found that the material would set up sufficiently within three or four days to take the full load and permit the removal of the shims and a final calking with an air tool. Any stains were removed by scrubbing with a solution of oxalic acid. One hundred pounds of the material, when rammed in rust joints of normal thickness, averaged about 0.65 cu.ft.

A. F. McLane is in charge of erection for the American Bridge Co. M. B. Case is senior resident engineer for the Delaware River Bridge Joint Commission, and Charles Elcook and C. L. Appleton are resident engineers of the Philadelphia and Camden approaches.

Scale for Setting Grade Stakes

By Leon F. Walker
Junior Engineer, Illinois Highway Division

FOR an aid in setting slope stakes in highway grading work I devised the scale shown below. This scale is made for use with the Illinois standard road section, but a similar one may be made for any road section. The middle scale gives the difference in elevation between grade and the point where the side slope intersects the surface of the ground. The upper scale gives the distance out from the center line to this point for a fill section, and the lower scale gives the distance out for a cut section. For example:

Grade is 425.00. The H.I. is 422.00, making the grade rod 3.0. A rod reading of 4.2 is taken on the ground surface giving a fill of 7.2. Above 7.2 on the middle scale the reading is 25.3 on the upper scale. The stake is set 25.3 ft. from the center line. I find that this scale is a great time saver, as it requires only a glance to see what the distance is for any cut or fill. The scale may also be made in the form of a slide rule to be used for any type of section.

SCALE FOR STANDARD ILLINOIS ROAD SECTION

From Job and Office

Hints that Cut Cost and Time

Bending Heavy Steel Reinforcing Into Semicircular Form

STEEL bars for reinforcing the concrete lining of the Pit No. 3 tunnel of the Pacific Gas & Electric Co. in northern California ranged in size up to 1¾-in. corrugated squares. This reinforcing was taken into the tunnel in the 35-ft. lengths required to reach halfway round the circumference, the bars having been bent to semicircular shape outside the tunnel where special equipment was installed for this purpose. Since a total of some 5,000 tons of steel had to be bent in this way the matter was given careful attention and the two types of benders described here were expressly developed for this purpose.

The type using an electric motor for power consisted of an adjustable set of rolls or wheels spaced so that a bar passing between them would be curved to a shape corresponding with the spacing of the rolls. The rolls which actually gripped and pulled the rods through the machine had corrugated faces and were made of cast iron deeply chilled. After passing through the rolls the forward end of each bar was guided in the desired curve by a piece of railroad iron spiked down on a heavy timber frame. As the rods left the rolls a crew of four men was used to carry them to storage piles nearby. In the larger sizes these semicircular rods weighed about 250 lb.

A simpler form of bender devised for use without the aid of mechanical power was constructed at the intake end of the tunnel. This consisted of a platform about 15 ft., square built at a convenient height above the ground on which a 14-ft. circle was laid out, made of 4x6-in. timbers and faced with a 6x¼-in. iron band. The circle was held in place by sixteen 4x6-in. radial timbers placed inside like spokes of a wheel. A recess containing a steel socket at one point on the circum-

POWER BAR BENDER IN OPERATION AT WEST PORTAL OF PIT NO. 3 TUNNEL IN CALIFORNIA

From Job and Office

For Contractor and Engineer

ference served as a receptacle for one end of the steel bar to be bent. A torque arm some 25 ft. long pivoted at the center of the circle and operated by a horse was arranged to carry two sheaves which rolled around the circumference, beginning at the socket where the rod was held fast and bending it against the steel plate as the rolls moved around. One of the sheaves, 6 in. in diameter, served as a guide on the steel facing of the circumference while the second, 14 in. in diameter, pressed against the steel rod and rolled it to the curve of the circumference. The diameter of the circle laid out on the platform gave the rods the desired curve.

Except that the use of horse power for moving the torque arm brought out the comment that this rig had all the appearance of an antiquated method, this bender was preferred to the mechanical type because it did its work fast enough, had a low operating cost, and required practically no initial investment. The power bender, on the other hand, a comparatively expensive device built by a San Francisco steel company, was made to work satisfactorily only after having been redesigned on the job by G. M. Wehrle, superintendent.

Trucks Have Separate Compartments for Sand and Aggregate

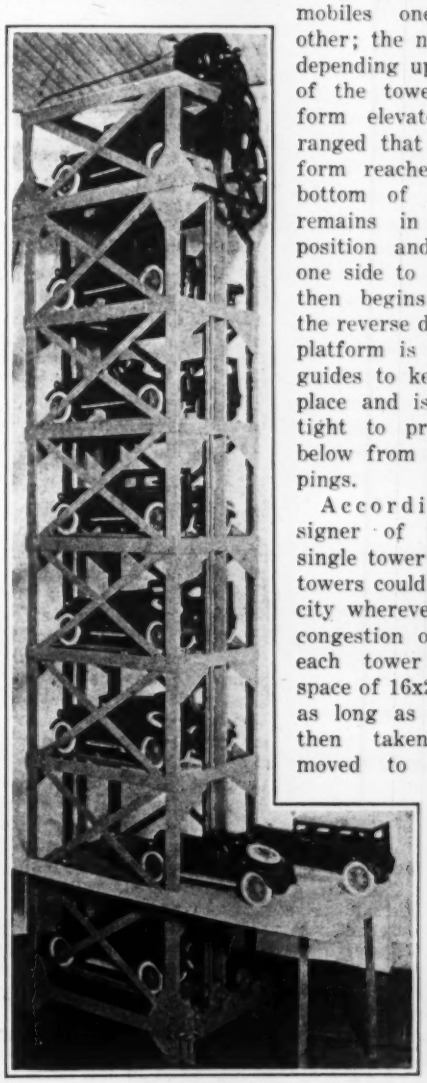
IN ORDER to eliminate the use of measuring hoppers at the sand and aggregate storage plant, several contractors furnishing material for paving work in New York City have fitted motor trucks with separate compartments of the required capacity for both the sand and the stone or gravel. Five batches of 1 cu.yd. each are carried by each truck. A batch is made up of 9 cu.ft. of sand and 18 cu.ft. of stone or gravel; three bags of cement complete the mixer charge. This method has been possible since a 1:3:6 mix is the standard for the concrete base for granite block pavement and the mixers used take the above charge.

TRUCK WITH SEPARATE COMPARTMENTS FOR SAND AND AGGREGATE

More rapid loading of the trucks is claimed to result from this method than when measuring hoppers are used. Also, most of these contractors sell sand and aggregate in large bulk quantities from their dock plant, in which cases the small measuring hoppers are impractical.

Parking Tower to Save Street Space

AN ARRANGEMENT for parking automobiles has been worked up at Purdue University consisting of a tower in which a series of platforms mounted between endless chains provide spaces for parking automobiles one above the other; the number of cars depending upon the height of the tower. The platform elevator is so arranged that as each platform reaches the top or bottom of the tower it remains in a horizontal position and passes from one side to the other and then begins to travel in the reverse direction. Each platform is provided with guides to keep the car in place and is made watertight to protect the car below from dirt and drippings.



MODEL OF AUTOMOBILE PARKING TOWER.

According to the designer of the tower, a single tower or a group of towers could be set up in a city wherever there was a congestion of automobiles, each tower occupying a space of 16x22 ft., and used as long as necessary and then taken down and moved to another site. Such towers could also be incorporated in office buildings and apartment houses or set up in small areas adjacent to theaters. The disadvantages of such towers are high cost of building of sufficient rigidity to stand in exposed positions, inequality of loading when one side of the tower is full of cars—which always exists while the tower is being filled—and high power of motor equipment and large current consumption.

The tower was designed by J. E. Morton, an engineering student at Purdue University.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Record Speed in Placing Concrete

Sir—In your issue of July 16, 1925, p. 113, Arthur S. Bent gives his concrete placing record at the Exchequer Dam, 47,000 cu.yd. per month, and asks whether any one has beaten this for a month's output.

During construction of the Arrowrock Dam (Idaho) we placed, in July, 1914, 56,520 cu.yd. of concrete in 26 working days, two 8-hour shifts per day, with a mixing plant of three 1-cu.yd. mixers. During four consecutive months we placed 205,000 cu. yd. with the same plant, an average of more than 51,000 cu.yd. per month.

At the Kensico Dam a considerably better record than this was made, but with larger mixers and more of them.

Dayton, Ohio, July 25, 1925.

CHARLES H. PAUL,
Formerly Construction Engineer, Arrowrock Dam.

Fort Worth Imhoff Tank Explosion Recalls One in South Carolina

Sir—I was much interested by the article on p. 54 of your issue of July 9 on the accident to one of the Imhoff tanks, at Fort Worth, Texas. The article starts off, "Parts of the partition walls of one of the Imhoff tanks were wrecked about March 1 by some sort of explosion (or perhaps water hammer) etc." Further on it is stated that there was considerable accumulation of petrolic materials in the tank, indicating that there may have been an accumulation of the lighter oils or gases from this petroleum waste.

An experience of mine some years ago may be of interest and may shed some light on this explosion. I had charge of a small sewage-works in a small city in South Carolina. The plant was supposed to work as a septic tank. The sewage, generally rather fresh but with some stale sewage from slow-flowing sewers mixed in, discharged into a partitioned tank about 10 ft. deep. This tank had baffles for directing the sewage towards the outlet. The cross-section between baffles was about 10 x 10 ft. There was practically no current. The action of the sewage was as follows: Settlement and accumulation of heavy deposits on bottom. Flotation and accumulation of heavy scum (felt) on top. The bottom sludge would generate gas particles that would float various-sized lumps of sludge to the top where they would lose their gas and again return to the bottom. Also the scum would get heavy and break up into various-sized pieces and then sink to the bottom. This change took place all the time. However, there was a semi-annual turnover period each spring and fall, when the rising and sinking of the sludge and scum was greatly accelerated.

From the septic chamber the partly clarified sewage was discharged onto intermittent sprinkling filters. Practically nothing was carried over to the filters except insoluble matter—seeds, lumps of grease, a little sludge or scum that was passing so close to the outlet that the current would carry it over, and other insoluble matter.

The councilman in charge of the works gave orders to the operator in my absence. The two of them drained down the plant and allowed all the sludge and scum in the plant to run into the creek. Neither the councilman nor the operator reported the matter to me. Shortly thereafter I ordered the operator to clean up the dead grass around the edges of the plant. He proceeded to burn it off.

There was a crack between the roof and the side walls of the plant. This crack was about 15 ft. long and from nothing up to about $\frac{1}{8}$ in. wide. The accumulation of raw sewage in the plant started to ripen and generate hydrogen gas (sulphuretted hydrogen) until there was an escape of this gas from this crack. When the fire reached the crack there was a terrible explosion. The 21 manhole covers, weighing about 150 lb. each, that were in the top of the tank were blown to various heights. Some of them went about 50 ft., and nearly broke through the top of the tank when they fell. Others were thrown higher, but luckily came down away from the tank and did no damage. One of them was never found but we supposed that it had fallen in the swamp nearby. There was no apparent damage to the walls of the tank. The force of the explosion was dissipated through the 21 manholes.

Maybe there was such an accumulation of gas in the Fort Worth tank and in some way fire was put to it.

McKEAN MAFFITT,
Superintendent, Water and Sewers.

Wilmington, N. C., July 12, 1925.

The Ft. Worth Imhoff Tank Accident

Sir—The article by Major John B. Hawley on the accident to the Imhoff tank unit at Ft. Worth, Texas, in your issue of July 9, p. 54, affords a striking example of one of the bad effects produced by accumulated scum in an Imhoff tank of the open gas vent type. An average Imhoff gas analysis would show approximately 30 per cent CO_2, 66 per cent CH_4, 4 per cent N_2. The inlet end of the tank generates considerably more CO_2 gas than the outlet end. CO_2 is about 1½ times as heavy as air and consequently remains in the scum until forced out by the lighter CH_4 rising from beneath. The scum itself normally analyses 90 per cent H_2O, 81 per cent volatile matter and 19 per cent ash. With such a scum 2½ ft. thick, the fine pores of which are thoroughly impregnated by oil, it would be quite possible for the scum to retain beneath it a considerable volume of CH_4. It would require at least 8 in. of such gas-filled scum in the transition chamber to equal in upward pressure the dead weight of the 3-in. cement septum wall, and a considerably greater depth to break the wall, into the sedimentation chamber, by direct static thrust. If the friction of the scum, corked into the gas vent, was suddenly overcome by the accumulated interior gas pressure, it would no doubt be blown out quickly by the expanding gases, leaving an unbalanced head of water, which would be lower on the transition chamber side of the septum, which when rising suddenly would create a sufficient force to break the walls into the sedimentation chamber.

In the Ruhr-Emscher District of Germany, some tanks are equipped with gas vents and side bypasses for the scum to be drawn off by sluice gates to the sludge beds. This does away entirely with the bad effect of scum production.

The writer has invented a method of exhausting the gases by suction over a closed gas chamber, burning the gases and heating a tank of water. The hot water is then pumped through a coil of pipe into and around the sludge chamber thereby raising its temperature to a considerable degree, which consequently will cause the sludge to generate more gases and leave less final residue for the sludge-drying beds. In existing tanks having scum trouble, the CO_2 gas can be absorbed and removed by injecting a sodium hydroxide solution into the floating scum, thereby allowing free passage for the escape of lighter gases.

In absence of more details of the accident, I am inclined to agree with Major Hawley that water hammer is finally responsible, though not primarily so, for the Ft. Worth accident.

Dallas, Tex., July 14, 1925.

H. L. THACKWELL,
Hydraulic and Sanitary Engineer, Fred A. Jones.

Setting Up Depreciation Reserves

Sir—In the keeping of financial records of to-day, the method of handling and accounting for the customary reserve to balance the loss in usefulness of physical units of property is far from being in the scientific state that it should be. This is a most important feature, charged as it is directly or indirectly to the operating expenses and therefore borne by the public.

To most people, this usefulness loss is known and recognized in the all embracing term "depreciation." To others, deeper in their knowledge, the term really covers many complex components such as inadequacy, obsolescence,

supercession, wear, tear, etc., each of which requires special treatment. Some idea of its relative monetary magnitude can be gleamed from the fact that the United States Government now engaged in appraising the steam railroads in the United States since the passage of the enabling Valuation Act in 1913, finds and reports 3½ billion dollars "depreciation" in this form of transportation.

Under present accounting rules and practices followed by the United States Government in the above instance, property units "depreciate" in an exactly *equal* degree from year to year and a reserve is accordingly set up on the basis that if the assumed life of a unit is 10 years, then it depreciates 10 per cent per year. No attempt has been made by the accounting profession in general to ascertain whether each unit actually does depreciate in an exactly equal yearly degree nor if the assumed lives adopted by them are anywhere near the facts. In this latter connection it is interesting to note the progress of actuarial science in the insurance field and to make a mental comparison therewith.

Of course, in order to do this, as every one understands, a high degree of knowledge in property operation and maintenance supplemented by a complete grounding in the principles of higher mathematics involved in statistical method and interpretation is required, all of which properly and naturally belong in the province of the training of the engineering profession. Therefore let us have the engineer, co-operating if need be with the accountant, study and analyze the service lives of simple and composite items of property under various operating conditions, scientifically sampling from the multitudinous renewal reports or others issued and making personal examinations and observations when necessary to substantiate the groundwork.

From such data, *accurate* life and degree of depreciation tables could be constructed and perhaps the formula of the unit cost theory could be so simplified as to enable the accountants to adopt this method in their bookkeeping to the exclusion of their heretofore used straight line theory. Further than this, operating vestances would then rightfully come into their own in the new era of financial engineering.

Let us try to have a proper rather than a hit and miss depreciation reserve set up in balance sheets as quickly as possible for the benefit of all concerned.

Philadelphia, Pa. WILLIAM E. OBERLE,
July 14, 1925. Engineer Analyst.

Building Live-Loads and Overloading

Sir—In an editorial published May 28, 1920, p. 878, you criticize the report of the Building Code Committee of the Department of Commerce on "Minimum live-loads allowable for use in design of buildings." To your criticism of the particular live-loads recommended for adoption I have no objections. The allowable design loads to be used for any particular building, where such loads are not prescribed by building laws, are largely a matter of judgment and experience, and it is presumably upon such past experience that minimum loads are fixed. But I take issue with you when you imply that buildings should not be designed for the normal loads which they will have to carry, but are to be designed for those abnormal conditions of loading which may occur very rarely, if ever. Such an assumed loading seems to be uneconomical and also poor engineering.

For example, if a building floor is designed for a live-load of 50 lb. per sq.ft. on a basis of 16,000 lb. per sq.in., is it to be assumed that under no circumstances is the live-load to exceed 50 lb. per sq.ft. as an absolute maximum?

Bridge engineers who have to pass on the capacity of old bridges in service know that such bridges if in good condition and subject to periodical inspections, may be safely overloaded by 50 per cent over the basic unit stress of 16,000 lb. per sq.in. For railroad bridges in good condition, the American Railway Engineering Association allows an overstress of 66 per cent, or practically a unit stress of 26,000 lb. per sq.in. If it is safe to overload a bridge 50 to 60 per cent, why isn't it just as safe when necessity requires it to overload the framework of a building to the same extent? In other words, with 16,000 lb. per sq.in.—or even 18,000 lb. per sq.in.—as a basic unit stress, is there not a sufficient margin of strength left in the material to take care of abnormal conditions of loading?

Again, where is our design load to stop? Tenants in office buildings are continually changing, and very often a change of tenants means a considerable change in live-loads. Books, safes and office equipment are often brought in which provide a load of unknown extent on the supporting structure. Where such loads are exceptionally large, the factor of safety of the material is certainly cut into.

As to designing buildings to make them interchangeable from one type of usage to another, it is questionable if any of our modern buildings have a sufficient length of life to warrant looking so far ahead.

Whether the recommendations of the Building Code Committee are adopted or not, it seems to me that their recommendation to design buildings for "probable actual" live-loads is based on sound judgment, the abnormal conditions being taken care of by the strength which building materials possess in excess of a basic design unit stress. It is the assumed basic design unit stress which is important.

Providence, R. I. E. M. VINER,
July 14, 1925. Structural Engineer.

Earthquake Hazards on the East Coast

Sir—On one point some exception may be taken in the admirable editorial on "Earthquake Hazards" in your issue of July 23, 1925. Your proposal to provide only a nominal resistance to earthquake forces of 1 to 2 per cent of gravity in other than the Pacific coast sections of this country apparently overlooks the past history of this Atlantic coast region and fails to recognize that, even if it is not advisable to provide greater resistance for many structures of a non-permanent character, some construction should be designed with an ample factor of safety against earthquake damage.

New England has had many earthquakes, some in the Eighteenth Century of considerable intensity that severely damaged the comparatively low but substantial buildings of that period. It has been suggested that the most severe of these earthquakes, that of 1755, was of approximately the same intensity as that in San Francisco of 1906. The great earthquake of 1663 along the St. Lawrence River in the province of Quebec did considerable damage in New England and must have been felt in New York as was the small disturbance in the same region last January. The destructive earthquake of 1886 in Charleston, S. C., is considered by the geologists to have been due to a displacement in the same mountain system that lies only a few miles west of New York City. In the highlands, 100 miles north of New York City, the geologists point out evidence of slight post-glacial faulting on the glaciated rock surfaces that indicates geologically recent movements. The probability of a slight warping of the earth's crust, as evidenced by the apparent subsidence of the Atlantic coast that is now going on in this vicinity, should not be overlooked, as such warpings may create stresses in the earth's crust and lead to readjustments that will severely shake this region.

Professor Jaggar points out that on a scale of seismicity in which the frequency of small earthquakes in such regions as Japan is 10, that of New York and New England is 8. We need not take as serious a view of the earthquake hazard in New York as does Professor Jaggar in his somewhat sensational article in *Scribner's* of last October, but the best geological opinion is that earthquakes of moderate intensity may be expected and steps should be taken to minimize property damage and loss of life.

The elimination of flimsy types of construction and provision for a small measure of resistance to earthquake movement may be sufficient in building construction of moderate height in small communities and in the residential districts of our large cities, but is it wise in face of the earthquake history of the Atlantic seaboard to design high buildings and other important structures for only a minimum of resistance to seismic disturbances? Should we not design, for example, the important features of our water-works to resist the maximum earth movement that may be anticipated and provide for the duplication of other features such as the trunk distribution mains that may not be built to resist such movements? Insurance against such a complete breakdown in service as occurred in the water-works of San Francisco in 1906, which was responsible for a fire loss that far exceeded the earthquake damage, would be worth many times the cost of providing it.

New York City, WALTER E. SPEAR,
Aug. 1, 1925. Department Engineer, Board of Water Supply.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Interstate Highways to Be Numbered Uniformly

Marking to be Similar Throughout the Country—Stop and Other Signs to be Standardized.

Some 50,000 miles of federal-aid roads have been selected by the Joint Board of Interstate Roads for numbering and marking in a uniform manner. The system will be divided into sixty routes. While the numbering is to be from 1 to 99, the actual assignment of numbers will not be undertaken until the system is mapped.

The board was guided largely by the recommendations of the state highway commissions, although it was found necessary in most states to reduce the number of routes recommended. This system as approved by the board connects all the larger market centers of the country and includes the roads carrying the main streams of interstate traffic. Every state capital will be on one of the numbered routes and some are on two or three.

The only controversy of the meeting developed over the road to be followed by one of the routes in Kansas. At the suggestion of the Secretary of Agriculture, who is from Kansas, the board over-rode the recommendation of the state highway commission. To cover this case, and others like it, the board decided that consideration should be given the recognition of an alternate route when roads divide and later reunite.

The standard marker for the routes is to be the United States shield, sixteen inches high. The background will be white. In the upper part of the shield the abbreviation of the state will appear in black. The route number will appear across the center, also in black, while in the lower portion of the shield the letters "U. S." will be shown. Odd numbers will be used for north and south roads and even numbers for those tending to run east and west. Other standard signs adopted by the board were as follows:

A white shield in a smaller size than the route marker on which will be printed the letters *R* or *L* as a precautionary warning on the approach of curves or turns in the routes. A similar sign with the addition of an arrow pointing in the proper direction will be posted immediately at the turn.

A circular sign 24 in. in diameter with a yellow background and bearing the familiar railroad cross in black with the letters *R.R.* also in black in the upper quadrants has been adopted for use at railroad grade crossings in all states in which existing laws permit the use of such a sign; and the board recommends that the use of the sign be authorized by suitable legislation in all states.

(Continued on p. 281)

Engineering Fifty Years Ago

From *Engineering News*, August, 1875

The Breaking of Iron Rails

IT SEEMS certain that after rails have been run over either a certain number of times or of years, they become much more brittle, and likely to break off square without warning. They may have proved to be sufficiently strong during the first few years after which they were laid, and then suddenly develop increased brittleness, and break in large numbers under the same class of rolling stock, and the same conditions of working as those which they have successfully withstood during previous winters. This has been partially counteracted on some lines by annealing repaired rails. For this purpose they have been roasted to a dull red heat, over fires made of old ties, and allowed gradually to cool, but the results have not been sufficiently satisfactory to warrant a continuance of the practice.

Trinidad, Col., Revisited by Large Flood

Heavy Rain of Short Duration Above City Causes Flood Less Than That of 1904

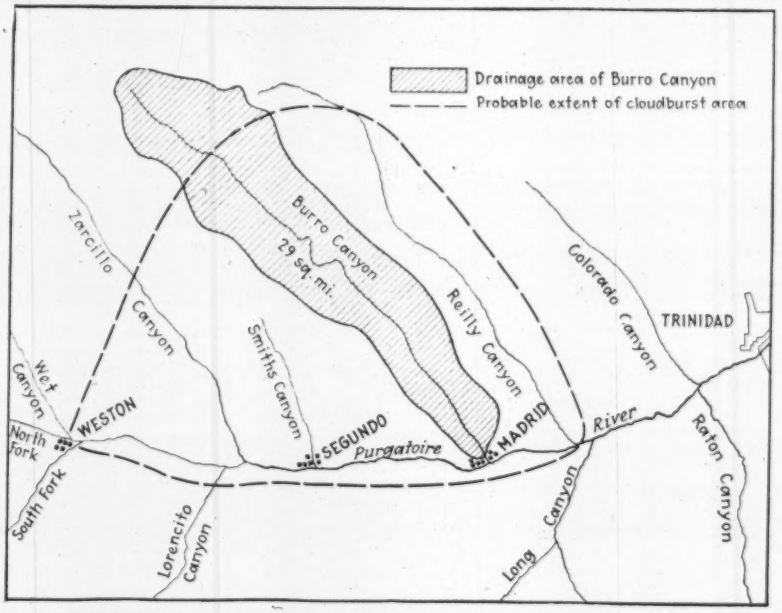
Special Correspondence

On July 22 a rain, originating on the South Fork of Purgatoire River, passed across the river at the forks, 24 miles above Trinidad, Col. At this point the storm changed to an easterly direction and as the storm travelled easterly, the precipitation increased. When the storm reached a point four miles below the forks, the rain was falling in torrents. The amount of precipitation was hard to estimate as no one seemed to have had any pails or pans out that could catch the water. There was one coal skuttle out in the open at Segundo at the mouth of Smiths Canyon that was filled by the storm. The amount of precipitation as measured by this would be 5 in. but this is believed to be too high. The duration of the rain at Segundo was from 5:10 p.m. to 5:50 p.m.

The heaviest runoff was from Burro Canyon, ten miles above Trinidad. The peak as computed from Chezy formula, using $n = .040$, was 24,800 sec.-ft. from a drainage of 29 sq. miles, or 860 cu.ft. per second per sq. mile. From the information available, the cloud-burst area was estimated to be about 90 square miles.

The greatest amount of damage was done at Segundo, being about $35,000 to the Colorado Fuel & Iron Co.

The largest runoff per square mile was probably at Smiths Canyon, five miles above Burro Canyon. The drain-



PORTION OF COLORADO SUBJECTED TO FLOOD, JULY 22, 1925

Contracts for Harbor Work Let

Contracts for the new harbor developments at Wolfe's Cove, Quebec, have been awarded by the harbor commissioners to the Northern Construction Co. Ltd., of Montreal. Dredging and cribwork represent approximately 68 per cent of the works covered by this contract, which will cost $2,500,000.

age area of Smiths Canyon was only 2 sq. miles but as the town of Segundo was located at the mouth of this canyon, a good section could not be obtained to estimate the runoff.

The peak of the flood passed Madrid, 10 miles above Trinidad at 5:50 p.m. and reached Trinidad at 7:30 p.m.

The flood peak at Trinidad was 33,000 sec.-ft. and at the canyon 33 miles below Trinidad was 32,000 sec.-ft. This last figure was due partly to a smaller flood that originated below Trinidad at 3:00 p.m. that afternoon so that no direct relation can be drawn between these two figures. The total amount of water passing Trinidad was approximately 8,200 acre-ft.

Comparison between the floods of Sept. 30, 1904 (See Water Supply Paper 147, U.S.G.S.) and July 22, 1925, at Trinidad are given below.

Date	Time	Gage Height Ft.	Discharge Sec.-Ft.	Total Discharge Acre-Ft.	Damage
Sept. 30, 1904	2:30 a.m.	16.6	44,300	21,170	$350,000
July 22, 1925	7:30 p.m.	10.2	33,000	8,200	70,000

The flood of 1904 was preceded by a heavy rainfall over the drainage area above Trinidad and the ground was thoroughly saturated at the time of the heavy storm of Sept. 29, while the flood of July 22 of this year was caused by a cloud-burst falling on dry soil with very little vegetation to stop the runoff.

The flood waters of 1904 came from the south side of the river from canyons that had a long drainage area, while the flood of this year came from the north side of the river from canyons of short drainage areas and steep slopes.

There were two floods previous to 1904, one in 1866 and another in 1886. It is impossible to get any data on these two floods except that they were both less than the 1904 flood. The rainfall at Trinidad during the 1904 flood was 5.05 in. in two days, while this year the precipitation at Trinidad was about 1.5 in. which fell mostly during the early afternoon and did not contribute materially to the high water of 7:30 p.m. but to the smaller flood of 3:00 p.m.

The peak of the flood reached the mouth of the river at 10:00 p.m. on July 23, or traveled 150 miles in 26½ hours.

The accompanying sketch map shows the approximate area covered by the cloud-burst.

Authority Asked to Construct Two Railroads in Florida

The South Georgia Railway Co. has applied to the Interstate Commerce Commission for authority to extend its line a distance of approximately 35 miles from Perry in Taylor County, Fla., to Deadman's Bay, a harbor on the West Coast of Florida on the Gulf of Mexico.

The Atlantic Coast Line Railroad Co. has also applied to the commission for authority to construct an extension of its present line from Immokalee to Deep Lake, Fla., a distance of about 27 miles. The work i to be financed out of the railroad's own funds without the issuance of new securities.

WASHINGTON NOTES

Revocation of Chicago's permit to continue its diversion of water from Lake Michigan is recognized as a possibility if there is failure to comply with its terms. The feeling is that the War Department was very liberal with Chicago in this matter and that further concessions hardly could be expected should there be failure to provide for the metering of water or to meet other conditions of the permit.

A bill providing for "an inventory of the water resources of the United States" will be introduced at the forthcoming session of Congress. The proposed legislation authorizes the director of the U. S. Geological Survey to make this inventory for use in setting up a comprehensive plan "for developing both surface and ground waters for domestic and industrial supplies, irrigation, navigation, power and other uses and for the conservation and control of flood water." An appropriation of $400,000 is sought for the first year's work and $500,000 for each year for 19 years thereafter.

The purpose of the bill is to expand the work of the water resources division of the Geological Survey and vest in that agency, among other things, the authority to make the general survey of the country's streams.

An ineffectual effort was made at the last session to secure legislation which would have enabled the Federal Power Commission to make such a survey, using license fees for the purpose. The Power Commission and the Corps of Engineers, however, were directed to report to Congress the cost of such a survey.

No unsatisfactory foundation conditions have been disclosed thus far by the boring which is in progress at various points along the St. Lawrence River. On Barnhart Island a shaft 12 ft. square is being sunk to a depth of 80 ft. From that depth it is planned to drive holes horizontally under the river. The swiftness of the current in the channel precludes vertical boring.

The City of Beaumont, Texas, has been requested by the War Department to remove, prior to Sept. 1, the dam which it has constructed across the navigable Neches River. The dam was built in connection with a plan for the city's water supply.

Copley Amory, of New York, has been retained by the Bureau of Reclaimation as a specialist in reclamation economics. Mr. Amory is regarded as an authority on western development.

Company Ordered to Refund Water Rates

The New York Interurban Water Co. has been ordered by a state supreme court judge to refund water charges collected since June 1, 1924, in excess of what the court holds to be reasonable. The total of the refunds is at the rate of $108,264 a year. The company is also ordered to pay the costs of the suit, which was brought by the towns of Mamaroneck and Harrison and the villages of Rye and Pelham.

Attempt to Stop Sea-Wall Work

The McDougald Construction Co., of Atlanta, Ga., has filed a suit in the Chancery Court of Harrison County, Miss., asking that it be recognized as the successful bidder for the county's $2,000,000 sea wall, and praying that the court enjoin the Woods Bros. Construction Co., of Lincoln, Neb., from proceeding with the work under a contract awarded to it on June 6. The suit of the McDougald company is based on a claim that its bid of $1,992,175 was $39,317 less than the bid submitted by the Woods Bros. Company.

The latter company has the work on the sea-wall under way.

Highways To Be Numbered

(*Continued from p. 280*)

The standard stop sign adopted is a regular octagon with the word "Stop" in black letters on a yellow background.

The caution signs are diamond shaped with a yellow background on which are superimposed the warning words and symbols giving notice of curves, hills, loose gravel, etc., ahead. In addition to these cautionary signs provision has been made for the use of "look" or "attention" signs to be used sparingly on approaching schools and other points at which caution may be necessary. These signs will be square with a yellow background and black letters.

In the selection of colors and shapes the board has been guided by the principle that all signs indicating the necessity for any degree of caution will be yellow. The degree of caution required will be indicated by the shape of the signs as well as by the words and symbols on them. Thus a round sign will always indicate a railroad crossing; an octagonal sign will indicate positive danger and will call for a complete stop; a diamond shaped sign will be equivalent to a command to proceed with caution; and a square, yellow sign will call attention to the need for a lesser degree of caution.

In addition to the warning and cautionary signs standards were also adopted for various forms of informational and directional signs, all of which are to be rectangular in form and to have a white background with black letters.

With respect to luminous signs the action of the board at its April meeting remains unchanged. The colors approved are red for danger or stop, yellow for caution, and green to indicate proceed.

Report Submitted on Value of Reinforcement in Concrete Roads

A progress report of the special investigation on the economic value of steel reinforcement in concrete roads was presented at a recent meeting of the executive committee of the Highway Research Board of the National Research Council.

The report showed that inspections have been completed on 375 miles of plain and reinforced concrete roads, varying in age from one to ten years, and containing approximately 300 comparisons of slabs with and without steel which were subjected to the same influencing conditions. These roads are located in Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, North Carolina, Georgia, and Ohio. The states still listed for inspection are Michigan, Illinois, Missouri, Wisconsin, Iowa, Utah, Washington, California, Texas, and Mississippi.

It is thus assured that a sufficient number of direct comparisons will be made to warrant drawing definite conclusions regarding the effect of steel as influenced by age, design, traffic, climate, and subgrade, as well as by the type, weight, and placement of the reinforcement itself. Detailed sketches, designs, and tables are being prepared which will give basic comparisons and a summary of results. Maintenance costs of both plain and reinforced concrete roads have also been secured on a large mileage. These costs are in such detail as to show how the maintenance is influenced by any desired variable.

The final report on this investigation will be one of the most complete studies on concrete roads ever undertaken. It will be presented at the fifth annual meeting of the Highway Research Board to be held in Washington, D. C., Dec. 3 and 4, 1925. As a supplementary feature of this report it is expected to have papers presented by representatives of several states which have compiled special information on plain and reinforced concrete roads. It is planned to devote one of the sessions of the annual meeting of the board to the discussion of this report.

Preparations Being Made for Navigation Congress in 1926

The American Section of the Permanent International Association of Navigation Congresses is making preparations for the next congress which is to be held in Egypt in 1926. The activities of the congress include not only such subjects as its name would indicate, but also such subjects as the development of power on navigable rivers, the application of concrete and reinforced concrete to hydraulic work, modern practice in lock design, and the influence of surface and subterranean waters on the flow of rivers. The program for the next meeting will be published in the near future. It will be sent to anyone upon application.

The secretary of the American Section is Major G. R. Young, Munitions Building, Washington, D. C.

Death of Walter M. Camp

Walter M. Camp, engineering editor of the *Railway Review*, and widely known in railroad and engineering circles, died in Chicago on Aug. 3. He was born at Camptown, Pa., in 1867 and had varied experience in railroad work, beginning as a sectionman and then a rodman on the Lehigh Valley R.R. Later he went to the Southern Pacific Ry., and then became engineer of construction for electric railways in seattle and at Chicago. Through his acquaintance with the late Willard M. Smith he became editor of the *Railway Review* in 1897 and held this position until his death. Mr. Camp was specially interested in railroad track work and published his "Notes on Track" some years ago. He was a graduate of Pennsylvania State College and took a postgraduate course at the University of Wisconsin.

Building Collapse Kills Five in Kansas City

A three-story brick building at 1109 Broadway, Kansas City, Mo., collapsed on Aug. 4, and killed five persons, three workmen and an elderly couple living in the upper floor. The building was being remodeled for a cabaret. Reports state that the permit for the work was not taken out until July 23 although the work had been in progress for nearly a month. The permit was for the construction of a concrete floor, nothing being said about changes in support walls, but such changes were being made when the collapse occurred. The superintendent of buildings has not completed his investigation.

Wooden Highway Bridge Collapses

A highway bridge on the Olympic Highway over the Little Hoquiam River at North Hoquaim, Wash., collapsed on July 30 while a passenger automobile containing three persons was passing over it. The bridge is reported to have had a span of 75 ft. and to have been built of wood. The occupants of the automobile escaped with slight injury.

Contract Let for Dam and Power House at Grand Falls

Contract for the dam and power house for the hydro-electric development at Grand Falls, New Brunswick, has been let to the Dominion Construction Co. of Montreal for $1,546,556. The contract was let by the New Brunswick Electric Power Commission. In all, eight bids were submitted, the largest being $1,819,041, or $234,000 below the engineer's estimate of $2,033,000.

Proportional Representation to Be Retained at Cleveland

An attempt to return from proportional representation to the ward system of electing councilmen at Cleveland, Ohio, was defeated on Aug. 11 by a popular vote of 21,042 to 20,238.

Random Lines

Over Here They Taper Down

"Taper Shanks up for Standardization in Sweden"—Sideline from a bulletin of the American Engineering Standards Committee.

* * *

Typographical Engineering

According to the *Bulletin* of the American Institute of Steel Construction, in 1920, the legislature of Virginia adopted a statute which provides that any contract executed within the State of Virginia is not enforceable in the courts thereof, if it contains printed clauses or conditions which are printed in type of a size less than 10-point. In several instances where this law was tested in the courts, the statute has been upheld as constitutional.

* * *

Newspaper Bridge Design

Someone please compute the stresses!

* * *

From Any One of 48 State Highway Departments

In the morning mail we got the following news release; on plain paper with nothing more to indicate where it came from than is reproduced here:

State Highway Department
News Release
Release Morning Papers

As the cost of keeping in repair bridges on uncompleted sections of the trunk line highway system will no longer be borne by the state following action of the Legislature, the state highway department has notified town selectmen of the change in the law which now requires the towns in which the bridges are located to maintain them. Attention of town officials is called, in the letter, to the provisions of the new law and copies of the act relating to the change have been sent to every town in the state.

This is only one of many that come from time to time. Its only difference from the somewhat similar case of John Smith who has nothing on his letter head but "John Smith, consulting engineer, Rochester," is that it is thoughtlessness, while in John Smith's case it is just conceit. Of course everyone knows which one of the twelve Rochesters would be important enough for John Smith to locate in, and needless to say, he is so prominent that all the postal clerks have his street number at their tongues' end!

Large Automatic Train-Control Contract Let

The largest single order for the installation of automatic train-control under the orders of the Interstate Commerce Commission for the installation of automatic control on one or more divisions of the principal railways of the country has been let to the General Railway Signal Co. by the New York Central Railroad Co. and its subsidiary lines. The contract covers about 1,000 route miles of railroad or approximately 2,600 miles of track and equipment for over 1,300 locomotives. The amount of the contract is between $4,000,000 and $5,000,000.

New Zoning Law for St. Louis

A new zoning law for St. Louis, Mo., being drafted by the City Plan Commission for submission to the Board of Aldermen in September will limit building heights to 12 stories unless the pyramidal type of construction is used. The cubical contents of structures with tower or setback stories exceeding 12 stories in height may not be more than that of a solid 12-story building. In some sections of the city the height limit will be but 45 feet.

The classifications according to use under the ordinance will be residential, multiple residential, commercial, industrial and unrestricted. Factories will be permitted only in the industrial and unrestricted sections.

A board of appeals of five members will be created to determine appeals from the building commissioner in the matter of permits under the zoning law.

46,000 Miles of Federal Aid Highways in Service

Nine thousand four hundred and forty-five miles of federal-aid road were brought to completion during the fiscal year ending June 30. An additional 4,587 miles is reported completed but has not been finally inspected and accepted, according to the Bureau of Public Roads.

The outstanding result of the year's work has been the large mileage of continuous highway routes made available. In practically every State gaps in through routes have been closed and many extensions made. Probably the most notable project opened to traffic is the Wendover cut-off across the Great Salt Lake Desert, which has removed an age-old obstacle to transcontinental traffic.

All of the construction has been on the designated Federal-aid highway system, consisting of approximately 175,000 miles. At the beginning of the fiscal year 35,452 miles had been completed with federal aid, and the year's work brings the total to more than 46,000 miles in service, since a considerable portion of the 17,123 miles reported as under construction has already been opened to traffic.

Texas led in mileage completed during the year with 784 miles, followed by South Dakota with 458 miles, Illinois with 431 miles, and Minnesota with 429 miles.

Great Northern 50-Mile Branch Line to Be Authorized

The Interstate Commerce Commission has stated that it will authorize the Great Northern Railway Co. to construct a branch line in Daniels and Valley Counties, Mont., from Scobey to Opheim, a distance of approximately 50 miles. The estimated cost of the construction is $1,450,000. The work is to be financed by a stock issue and from current income; authority for which will be the subject of further action on the part of the commission. Work is to be commenced immediately.

Engineering Societies

Calendar

Annual Meetings

NEW ENGLAND WATER-WORKS ASSOCIATION, Boston, Mass.: Annual Convention in connection with trip on St. Lawrence River, Sept. 8-11, 1925.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City: Fall Meeting, Montreal, Que., Canada, Oct. 14-16, 1925.

AMERICAN PUBLIC HEALTH ASSOCIATION, New York City: Annual Convention, St. Louis, Mo., Oct. 19-22, 1925.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, Lakeland, Fla.: Annual Meeting, Des Moines, Iowa, Oct. 26-30, 1925.

The American Welding Society will hold its fall meeting Oct. 21, 22, and 23, 1925, in Boston, Mass., at the Massachusetts Institute of Technology. There will be five technical sessions and an exhibit of welding and welded products, also actual demonstrations of welding and cutting.

The North Carolina Society of Engineers held its ninth annual convention at Morehead City, Aug. 7 and 8.

The Duluth Engineers' Club at its annual meeting on Aug. 4 elected R. S. Huey president, and W. H. Woodbury and Earl E. Hunner, vice-presidents. The club voted to retain its affiliations with the Minnesota Federation of Architects and Engineers and with the American Engineering Council.

Personal Notes

CAPT. FREDERIC ANDERSON has been appointed chief hydrographer of Canada, Department of Marine and Fisheries, in succession to the late W. J. Stewart. Captain Anderson had recently been in charge of Atlantic Coast surveys off the coast of Nova Scotia and on the Bay of Fundy. He has been in the survey work since graduation in 1890, in various operations on Georgian Bay, and Lake Winnipeg, in charge of Canadian survey on the Great Lakes from 1905 to 1910 and then in charge of survey on Hudson Bay and Hudson Strait, investigating the navigability of the strait.

RAY PALMER, formerly commissioner of gas and electricity of Chicago and for the past nine years president of the New York and Queens Electric Light and Power Co., announces that he has resumed his consulting practice relative to reorganizations, appraisals, valuations and public utility and industrial problems, with offices in the Vanderbilt Concourse Building, New York City, and in the Illinois Merchants Bank Building, Chicago.

MILES N. CLAIR has resigned as instructor in civil engineering at Drexel Institute, Philadelphia, to take charge of the testing department of the Thompson & Lichtner Co., Boston. At Drexel Institute Mr. Clair had charge of the materials laboratory.

MILES C. BLAND, formerly resident engineer on the Philadelphia-Camden bridge during the earlier stages of construction, has been appointed an assistant engineer in the Department of Public Works, city of Philadelphia.

HERBERT LUDLOW has succeeded C. M. Cooper as county engineer for Crawford County, Kansas, on August 5. He is a graduate of Cornell University and formerly was connected with the State Highway Department of Pennsylvania.

J. J. JOHNSON, district engineer, U. S. Bureau of Public Roads at Denver, has had his territory extended to include the state of New Mexico.

Obituary

HERBERT C. BURWELL, consulting engineer, Vancouver, B. C., died in that city July 30 at the age of 62. Mr. Burwell began practice as a civil engineer with the firm of Tracy & Durand and subsequently spent the years 1884 and 1885 on the Canadian Government survey of North Labrador, one of the ports there being named after him. In 1887 he went to Vancouver, B. C., and became a member of the firm of Yardin, Herman & Burwell, consulting engineers. Mr. Burwell remained in Vancouver and in recent years acted as consulting engineer for the city.

FRANCIS J. LLEWELLYN, division contracting manager of the American Bridge Co., died at Portland, Ore., on July 25. He was born in England in 1861 and came to this country in 1884, where his first engagement was as superintendent for the Gillette-Herzog Co., structural steel contractors, at Minneapolis, and in 1886 he became vice-president and chief engineer of that company. He was made contracting manager of the American Bridge Co. in 1901.

ALEXANDER M. DENTON, civil and mining engineer, died recently in San Diego, Calif., aged 50 years. He was born in Mexico.

From the Manufacturer's Point of View

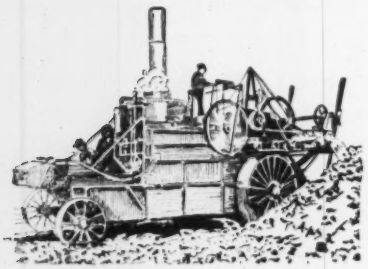
A Point of Contact
Between Maker and User of
Construction Equipment and Materials

Construction Equipment—Past and Present

A Series of Historical Sketches of the Origin and Development of Machines for Contractors and Engineers

VIII—Trench Excavators

THE modern trench excavator is a result of the adaptation of principles used in older excavating machinery to present-day requirements in the construction industry that necessitate a trench being opened only long enough to lay the pipe line, after which it may be immediately back-filled. The first continuous bucket excavator was patented in 1859, by M. Chevreux, a Frenchman, and was used on the Suez Canal. In fundamentals of design it was the prototype of the present trench excavators especially those of the so-called "ladder" construction which use a boom that is lowered into the ditch and that forms a track for a continuous bucket system. This excavating machine of the fifties, however, was used only for wide and open ditches, with sloping sides while the trench excavator, as now commonly designated, is built fundamentally for digging trenches that have vertical sides



Early Austin Excavator Used by Municipal Eng'g. & Cont. Co.

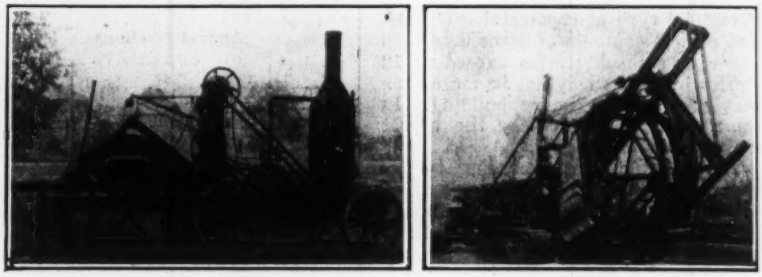
and a considerable depth in comparison to their width.

The history of such trench excavators is of American origin and dates back to about 1887. At that time the F. C. Austin Mfg. Co., Chicago, now the Austin Mfg. Co., purchased the business of a manufacturer of horse-drawn "wheel" machines made in Windsor, Canada. Shortly afterwards the patents of a ditching company in Columbiana, Ohio, were acquired. Concerning the machine made by this company, F. C. Austin, one of the pioneers in the excavating machinery field, says: "This was a large turntable affair, in appearance something like the tail-board of an old style reaping machine where the sheaves are raked off semi-circular fashion."

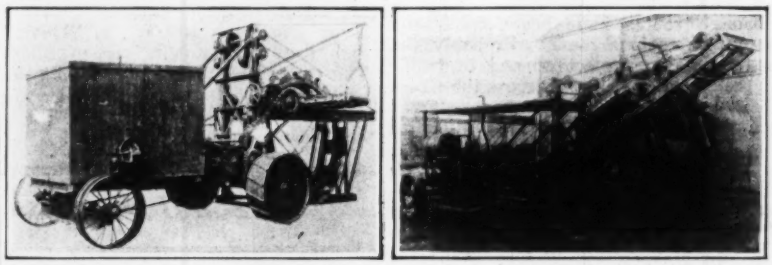
Wheel Type—While these developments were taking place, the Buckeye Traction Ditcher Co., Findlay, Ohio, commenced the manufacture, about 1889, of a machine whose purpose was to dig trenches for tile drainage systems. This machine was of the wheel type, utilizing the continuous bucket principle of the ladder type, but in this case having the digging buckets placed around the outer periphery of a wheel and arranged to dump toward the center of the wheel onto a continuous spoil belt. With the exception of the power plant and traction equipment, this early Buckeye machine strikingly resembles the wheel type excavators used at the present time; a comparison of these two machines shown in accompanying illustrations, gives a picture of the development of the wheel type trench excavator during the past thirty years.

The old-time machine was sold under a guarantee that the machine must "dig a trench 11½ in. wide and any depth up to 4½ ft. at a rate of 3 lin. ft. per min." The power unit consisted of an upright boiler and a single cylinder slide valve engine. The hoisting of the digging wheel, maintenance of grade, and steering of the machine were accomplished by hand power. Contrast this with the present machine that will dig 12 ft. deep, up to 2 ft. wide and whose speed of travel must often be reduced so that pipe laying operations may not be left too far behind. While the earlier machines would dig from 50 to 100 ft. per day, the later types consistently show runs of from 800 to 1,500 ft. per day. Record runs exceed this maximum by 100 per cent. The present machine uses either steam or gas engines for power requirements and is invariably mounted on crawler traction treads.

Early Ladder Type—In 1895 the Austin ladder type machine appeared. Not a great deal is recorded on the development of this machine during the closing years of the nineteenth century, but an account in *Engineering News*, Sept. 19, 1901, indicates that its use was then still the exception and the cause for considerable comment. This account says in part: "Among the recent developments in excavating machinery is a trench excavator manufactured by the F. C. Austin Mfg. Co., and used on sewer work in Glencoe, Ill.; this machine does the work cheaper and quicker than by hand. The machine is mounted on four broad-tired wheels and hauls itself along by means of a wire cable anchored about 300 ft. ahead. Power is derived from a 25-hp. traction engine. The machine excavates 500 to 600 ft. of 13 to 15-ft. trench in ten hours."



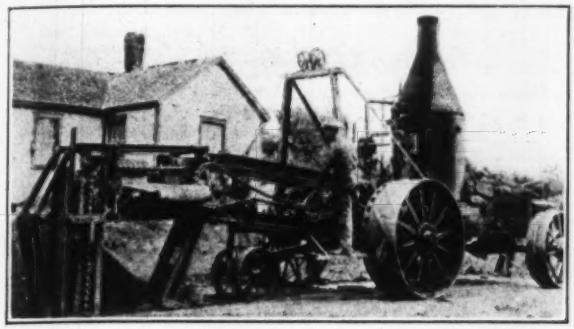
Earliest and Latest Buckeye Wheel Type Excavators



Development of Wheel Type Excavator of Harnischfeger Corporation

Early Marketing Procedure—The first Buckeye machines were invariably sold by mail, no salesmen being employed until the growth of the business and competition made such a step necessary.

Since all trench excavators were in an especially experimental stage, the first machines made by the Austin Mfg. Co. were leased on a pay-for-work-done basis so that the company could keep records of performance which could be used as a basis for improvements in design. Shortly afterwards the Municipal Engineering & Contracting Co., Harvey, Ill., was given the exclusive right to use these machines but the fallacy of such a method of distribution was soon demonstrated by the increased and widespread demand for trenching machines.



Original Parsons Excavator (1905)

Parsons Excavator Equipped with Early Type Crawler Treads

Development of Ladder Type — The ladder type of trenching machine, being able to dig a deeper ditch than the wheel type—the earliest ones excavating to 10 ft.—was more suitable for municipal contractors who had to lay water mains. Because of this wider range of adaptability the ladder type experienced a rapid growth. The G. W. Parsons Co., Newton, Ia., now the Parsons Co., came into the field to manufacture this type exclusively and produced its first excavator in 1905. This machine was characterized by a wooden A-frame for hoisting the digger and wooden stiffeners for the vertical part of the boom. The buckets followed a framework in the form of a right-angle triangle, dragging the material out of the ditch along the hypotenuse. The digging boom was supported on small trailer wheels.

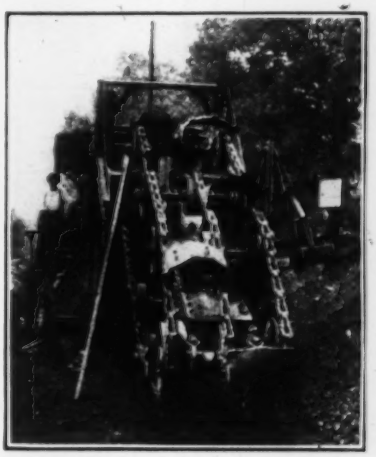
Design changes in the Parsens machine occurred rapidly; heavier materials were used, the digging conveyor chain assumed an oval instead of the former triangular shape and gears were substituted for chains where possible. The weight of this machine was 30,000 lb.; a similar machine in 1914 weighed 60,000 lb. The change from steam to gasoline power occurred about 1911.

Parsons Excavator Equipped with Old Type Articulated Buckets

The Harnischfeger Corp. then Pawling & Harnischfeger Co., of Milwaukee, and a very old firm in the excavating machinery field, built its first trench excavator in 1913 and used a gasoline engine as a power unit. All of this company's trench excavators have subsequently utilized gasoline for motive power.

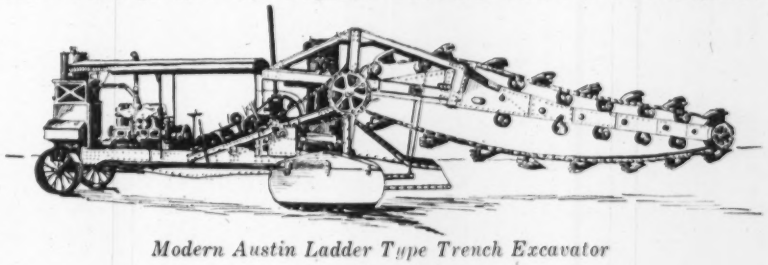
The Buckeye Co., previously confining itself to wheel type excavators, entered the field in 1915 with a ladder excavator, the largest model of which would dig a trench 7 ft. wide by 20 ft. deep.

Materials Used — From the earliest machines which utilized a considerable number of wooden members in their construction the trench excavator has been developed into an all-metal machine even including in some cases the spoil conveyor belt. In the earlier type machines gray iron castings and malleable drive chains were used to a great extent. Very few finished castings or turned shaftings were available. Beginning in 1909, gray iron castings were replaced by steel. Long articulated buckets made of steel plates were common on early machines while at present steel castings are used. Alloy steels, for the most part manganese, are extensively used for such parts as bushings, pins, and bucket lips and teeth.



Ladder Type Excavator with Two Rows of Buckets (Austin Mfg. Co.)

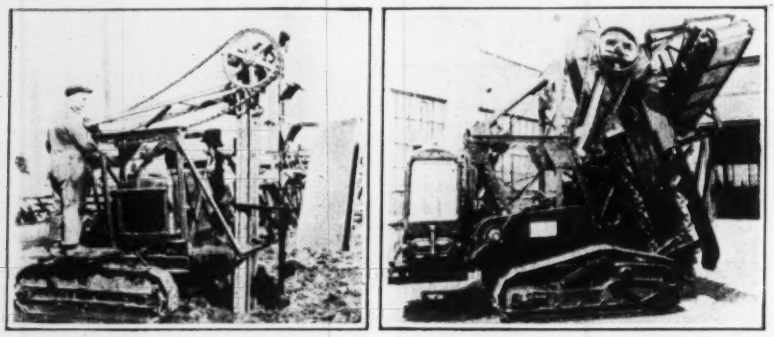
Traction and Propelling Mechanism —Crude methods of propulsion were utilized as shown by the description of the early Austin trencher in *Engineering News*, although the following statement appears in a catalog of the nineties: "The reader should remember that the Buckeye trench excavator is a traction engine and can be used for any purpose that a traction engine is suitable." About 1911, crawler traction treads began to be extensively used. The World War materially speeded up the adoption of this type of mounting until now it is the rule rather than the exception. At first, the treads were made of armored wood but cast steel was soon adopted.



Modern Austin Ladder Type Trench Excavator

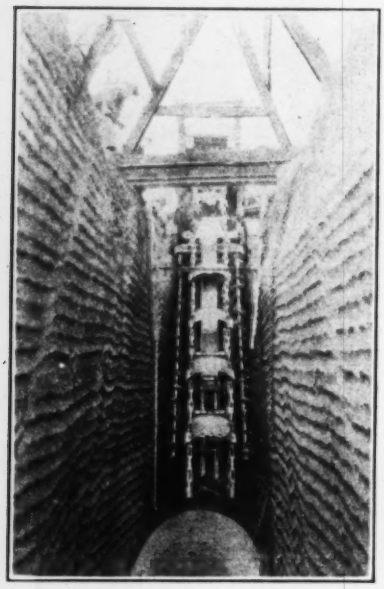
Modern Parsons Excavator (Note enclosure of working parts)

The first machine of the Harnischfeger Corp., built in 1913, was characterized by a small number of chains, gearing being used whenever possible. It also contained a multiple feed produced by sliding gears, making it possible to obtain quick changes of digging speed. Other companies had adopted the direct worm drive both for the digging buckets and propulsion. Gears were enclosed and ran in oil. At first the crawler tread was merely placed around the large rear wheel of the old excavators. As the need for distribution of the weight over a wider area became necessary, long oval-shaped treads were adopted, their driving mechanism consisting of cog wheels driven from the engine by worm gears.



Evolution of Barber-Greene Trench Excavator (1920-1925)

Small Size Ladder Excavators—Wheel type trench excavators have always been built in both small and large sizes but it was usually considered impractical to build a small "ladder" machine, partly on account of the fact that it was not thought possible to build a sufficiently rugged machine in small capacities and partly because of the difficulty in keeping the light-weight boom and buckets down to the ground in hard soil, since the tendency was for the boom to ride up out of the trench. Heavy steel castings and the utilization of a power mechanism that held the boom in the bottom of the ditch overcame these difficulties and made a small machine possible. Prototypes of the heavy ladder type excavators are now common equipment in small capacities, one of the first being made by the Parsons Co., in 1921, and designed to excavate to a maximum depth of 6 ft. and from 12 to 21 in. wide.



Modern Buckeye Machine with Revolving Attachment for Widening Ditch

In line with the possibilities for a light weight machine, Barber-Greene Co., Aurora, Ill., adapted its self-feeding bucket loader to trenching purposes. This new machine was produced in 1920 and radically departed from the conventional design for trench excavators. Instead of dragging the excavated material up an incline the digging boom was perpendicular and literally elevated the material. The advantage of this design lies in the fact that it enables a ditch to be dug for its full depth right up to an obstruction.

Miscellaneous Improvements — Gasoline power has replaced steam to a great extent in trench excavator practice. Gasoline machines are manufactured with ratings up to 75 hp. while the largest steam machines are rated about 40 hp. Special appliances permit machines to widen their range of operation, among which are revolving side cutters attached to the ladder frame of the digger boom, trimming the sides and making a wider ditch possible. Another auxiliary is an extra boom which will permit the ladder type machine to dig to a depth of 34 ft.

Modern machines are not only self-propelling while digging but will travel over roads at a rate of 1 to 3 miles per hour. Bucket cleaning devices are common to all machines while the lack of them made early machines inadequate for many kinds of soil. Systems of forced lubrication are being adopted, as on other construction machines. A device used on some modern machines consists of a shield attached to the rear end of the excavator. In this the pipe layers may work with comparative safety from cave-ins.

The trench excavator is one of the monumental results of the development in manufacturing methods which have made possible castings, gears, and chains that will withstand practically any degree of hard usage. The machine was developed to meet a demand for shallow tile drainage ditches; having met this demand, constructors sought its adaptation for deeper water main and sewer ditches. The manufacturing plants and research engineers have been and are still providing the more efficient workmanship and materials that are necessary to meet the more exacting operating requirements of deeper digging and increased speed.

Business Notes

L. R. MacKenzie and Associates, Inc., incorporated under the laws of Delaware to transact any business allied to engineering or construction, have opened offices in the National Association Building, New York City, and in Hackensack, N. J. The corporation holds the exclusive license from the American Vibrolithic Corp. to authorize the construction of two distinct types of improved pavements in the area covered by the New England and Middle Atlantic States and the District of Columbia. These two types of pavement are Armor-plated Vibrolithic Method Cement Concrete Pavement, and Vibrolithic Method Interlocking (base with surface) Bituminous Pavement. L. R. MacKenzie, president, was formerly the district engineer of the Portland Cement Association for the state of Iowa. A. R. Hirst, vice-president and chief engineer, was for seventeen years state highway engineer of Wisconsin. He resigned that position in May, 1924, at the same time announcing his candidacy for the governorship of Wisconsin. He was defeated by the La Follette candidate and then became chief engineer of the American Vibrolithic Corp., which position he still holds.

Publications from the Construction Industry

Big-Hole Drilling — Sanderson Cyclone Drill Co., Orrville, Ohio, has just issued a new 108-p. catalog known as B-55, which deals with big-hole drilling and blasting and its application to quarrying, open-pit mining and heavy rock excavation. The first 50 pp. of this book are essentially a treatise on the history and the fundamental factors in big-hole drilling methods. There are given, in this section, among other things, analyses of the problems encountered in the several different kinds of rock strata, the proper size, arrangement and spacing of holes for different rock strata, detailed comparisons of this method with all other methods of rock drilling, and operating and cost data. The last part of the book is the catalog proper, giving descriptions, both in text and tabular form of the company's line of drills and drilling equipment.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Cost Stability Indicated by Quantities of Materials Used Consistent with Increase in Money Value of Contracts

Construction keeps ahead of last year, from week to week, not only in money value of contracts let but also in volume of materials used. This indicates cost stability.

With increasing demand, production schedules have been stepped up to a point where there is no scarcity of any basic material.

Transportation facilities are good and the responsibility of carrying reserve stocks is therefore forced over upon the mills.

Materials dealers claim, however, that their chief concern at present is not in obtaining the materials but in disposing of them at a fair margin of profit.

Concrete aggregates and other basic materials are being stored at docks and other places in anticipation of an active Autumn building program. Present conditions as to demand and output of steel, lumber, cement and brick, are as follows:

Steel—Conditions at mills are improving from week to week, with operations mostly at about 70 per cent of capacity. Pig iron furnaces are also beginning to resume in greater numbers. Ingot output, Jan. 1 to Aug. 1, is over 17 per cent greater than for the corresponding period last year. Calculated monthly production of ingots, all companies in the United States, according to the American Iron and Steel Institute, follows:

	1925 Tons	1924 Tons
January	4,198,564	3,649,913
February	3,756,243	3,826,246
March	4,198,520	4,206,699
April	3,587,524	3,348,466
May	3,458,253	2,640,034
June	3,207,056	2,065,676
July	3,087,590	1,877,789
7 months	25,493,750	21,614,823

The trend of steel demand is shown in the report of unfilled order on books of the U. S. Steel Corporation, July 31, amounting 3,539,467 tons. This is below the June 30 total of 3,710,468 tons but considerably ahead of the 3,187,072 tons unfilled on July 31, 1924.

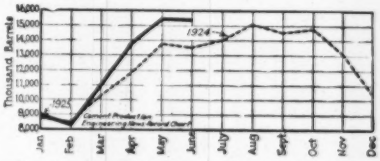
Lumber—The National lumber movement for the first thirty-one weeks of 1925, compared with the corresponding period last year, shows a substantial increase all along the line, in production, new demand and shipments on old orders. The following figures are by the National Lumber Manufacturers' Association:

	Production Ft. b.m.	Shipment Ft. b.m.	Orders Ft. b.m.
1925	7,517,727,727	7,453,286,419	7,298,424,835
1924	7,224,478,933	7,180,784,360	6,886,277,035
1925 Increase	293,248,794	272,502,059	412,147,800

The following tabulation compares the national movement for the three weeks indicated:

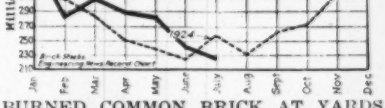
	Week of Aug. 1, 1925 Ft. b.m.	Corresponding Week, 1924 Ft. b.m.	Preceding Week, 1925 Ft. b.m.
Production	237,516,744	209,070,721	233,583,865
Shipments	262,048,482	235,914,810	233,773,455
New demand	259,883,296	251,535,492	239,476,734

Cement—With record mill shipments and production at very nearly a record mark, this industry has come into prominence, to a degree equal with steel, as a barometer of construction. Mill reserves, available July 1, although showing seasonal decline, are substantially ahead of a year ago. The present activity will probably hold for another two months.



OUTPUT OF NATION'S MILLS—U. S. BUREAU OF MINES

Brick—There are more bricks ready for burning at yards throughout the country, than there were a month ago



BURNED COMMON BRICK AT YARDS IN U. S.—COM. BRICK M'F'RS ASSOC. OF AM.

or one year ago. There are, however, fewer burned bricks ready for shipment and unfilled orders on books. Movements from yards have slowed down a trifle recently but are still considerably ahead of a year ago. The Common Brick Manufacturers' Association of America further reports, Aug. 1, 1925, that "orders on books are more than 200 per cent of the amount of brick moved during the preceding month. This is the highest ratio between orders and shipments reached during the year."

This Week's Contracts Reach Record Value

The money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks.

Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial buildings.

MONEY VALUE OF CONTRACTS LET—ENTIRE U. S.

Week Ending	Public Work	Private Work	Total Contracts
Aug. 13, 1925	$18,556,000	$56,302,000	$74,858,000
Aug. 6, 1925	22,893,000	26,781,000	49,674,000
Aug. 14, 1924	23,960,000	22,786,000	46,746,000
Heaviest Week			
1925, Aug. 13	18,556,000	56,302,000	74,858,000
1924, May 8	26,370,000	38,829,000	65,199,000
Jan. 1 to Date			
1925	645,456,000	835,667,000	1,481,123,000
1924	641,779,000	670,290,000	1,312,069,000

Construction Cost Per Capita Is Three Times as Great as in 1913

With the exception of the two war years (1917-18), a charted trend for each of the most important classifications of construction covering a period of twelve years would show a gradual incline upward.

The accompanying tabulation is based upon statistics compiled by *Engineering News-Record* with the following restrictions as to minimum contract value for the various classes: water works, $15,000; sewers, bridges, streets and roads, $25,000; industrial works, $40,000; commercial building, $150,000. The population figures for the United States are estimates made by the Bureau of Census, Department of Commerce.

For illustration, the capitatim

(*Continued on p. 288*)

PER CAPITA EXPENDITURES FOR SIX IMPORTANT CLASSES OF CONSTRUCTION IN U. S DURING PAST TWELVE YEARS

Year	Population of United States	Water Works	Sewers	Bridges	Streets and Roads	Industrial Building	Commercial Building	All Constr.
1913	96,512,407	$0.215	$0.282	$0.235	$0.605	$0.425	$2.223	$6.231
1914	97,927,516	.225	.373	.337	.743	.390	1.822	5.952
1915	99,342,625	.217	.355	.236	.785	.913	1.849	5.877
1916	100,757,735	.241	.39	.411	1.557	2.578	2.011	9.263
1917	102,172,842	.273	.326	.235	1.011	1.711	1.802	7.136
1918	103,587,955	.122	.169	.166	.711	2.52	1.129	9.589
1919	105,003,065	.188	.366	.258	2.149	3.63	3.212	11.198
1920	106,418,175	.208	.351	.317	2.490	4.245	5.388	14.312
1921	107,833,284	.355	.959	.276	2.905	1.094	5.212	11.068
1922	109,248,394	.334	.399	.398	3.063	1.813	6.872	14.748
1923	110,663,504	.566	.605	.605	3.261	2.544	7.608	17.172
1924	112,078,613	.549	.665	.611	3.705	1.828	8.341	17.865

Weekly Construction Market

BUILDING materials prices are firmer now than at any time since the first of the month. The upward trend affects c.-i. pipe, fir timbers, common brick and raw linseed oil.

Aside from a rise in linseed oil occurring in New York, all the other advances were in the West. A slight drop, however, is reported in Southern lump lime.

There is an unusually heavy current demand for building materials in the Chicago district. Movements of sand, gravel and stone exceed anything thus far experienced in that section.

Construction in Seattle and the Puget Sound cities is more active than a month ago. Douglas fir lumber mills have advanced all grades $1 to $2 per M. ft. Further increase is expected. Tacoma reports a notable gain over a year ago in number and value of building permits issued.

In St. Louis the money value of building permits is heavier than a year ago but there is considerable decrease in the number issued, making for a higher cost per project.

All July records in value of permits issued were broken last month in Columbus, Ohio; Los Angeles, however, showed a slight drop in both number and value, compared with a year ago.

Montreal reports a slackening of construction operations. The present influx of aliens is increasing the available supply of labor.

New York construction, Jan. 1 to date, is below that of the corresponding period last year. The jurisdictional dispute between bricklayers and plasterers has not seriously retarded the building program, since only between 5,000 and 8,000 men are involved. More concern is expressed over the possibilities of a demand for higher building trades' wages after Dec. 31, 1925, at which time the existing contracts expire.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb	$3.34	$3.90	$4.00	$3.10	$3.35	$3.07½	$3.30	$3.35	$4.25
Structural rivets, 100 lb	4.50	4.45	4.75	3.50	3.75	4.65	5.00	3.75	6.00
Reinforcing bars, ¾ in. up, 100 lb	3.24	3.40	2.80	3.00	3.25	3.62½	3.35	3.25	2.30
Steel pipe, black, 3½ to 6 in. lap, discount	48%	58%	53.6%	51%	54.25%	36%	39.2@51%	50%	59.49
Cast-iron pipe, 6 in. and over, ton	50.60@51.60	45.80	54.00	+50.20@54.20	53.00	62.00	52.00	53.00	55.00
Concreting Material									
Cement without bags, bbl.	2.50@2.60	2.40	2.05	2.20	2.42	2.84	2.31	2.65	1.80
Gravel, ¾ in., cu.yd	1.75	1.90	2.38	1.90@2.20	1.65	1.90	2.15	1.50	1.25
Sand, cu.yd	1.00	1.40	2.00	1.90@2.20	1.25	1.00	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd	1.85	2.00	2.83	1.90@2.20	1.75	2.50	2.15	3.00	1.90
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	59.00	34.00	58.50	45.00@55.00	38.75	+37.75	27.00	+24.00	60.00
Lime, finishing, hydrated, ton	18.20	22.50	18.00	20.00	25.50	24.00	22.00	24.00	21.00
Lime, common, lump, per bbl	2.25@2.75	—1.30	1.85	1.30	1.35	2.70	1.60	2.80	9.50
Common brick, delivered, 1,000	18@19	10.50	11.60	12.00	13.50	12.00	+15.50	15.00	17.50
Hollow building tile, 4x12x12, per block	Not used	.0888	.10	.075	.....	.085	.....	.10	.12
Hollow partition tile 4x12x12, per block	.1162	.0888	.10	.075	.07	.085	.108	.10	.10
Linseed oil, raw, 5 bbl. lots, gal.	+1.06	+1.11	1.13	+1.00@1.04	+1.12	1.19	1.10	1.12	1.25
Common Labor									
Common labor, union, hour	.75	.30	.....	87½	.....	50@.55	.55	.62½	.....
Common labor, non-union, hour	.....	.25	30@.50	+.82½	50@.55	35@.50	.50	.50	.25@.35

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Labor—Concrete laborers' rate, 93¾c.; building laborers, 75c.; excavating laborers, 55c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone delivered on job.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.60 for Sheboygan. Common labor not organized.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of August 6, the next on September 3.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on pine lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 100.03). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 3½-in., $59.49.

Construction Cost Per Capita Is Three Times as Great as in 1913

(*Concluded from p. 287*)

amount for 1924 for water works, sewers and bridges is 3 times that of 1913. Streets and roads costs for this period are 6 times as great; industrial works, 4; commercial buildings, 3¾.

On August 1, 1925

E. N.-R. Construction Cost Index Number 204.60

E. N.-R. Construction Volume Index Number 178

For Explanation and Details of Indexes Since 1913 See the First Issue of Every Month